SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST, 1926.

GENERAL PHYSICS.

1731. *Viscosity of Gaseous Mixtures.* **M. Trautz and A. Narath.** (Ann. d. Physik, 79. 7. pp. 637–672, April 23, 1926.)—This paper contains a detailed account of experiments on the viscosities of mixtures of gases at different temperatures. First, the viscosity coefficients of mixtures of hydrochloric acid gas and hydrogen are determined at 21°, 54°, 99°, 154°, 200°, and 250°, and the isothermal viscosity coefficient-molar fraction diagrams constructed. In the diagram for hydrochloric acid maxima occur which are well defined at low temperatures, but flatten with temperature elevation and almost disappear at 250°. The line joining the maxima is straight. At low temperatures the viscosity increase by addition of hydrogen is proportional to its molar fraction, but loses this simple regularity at higher temperatures. At about 310° hydrochloric acid no longer exhibits a maximum. The Sutherland constant was determined for hydrochloric acid to be 362 and for hydrogen 83·7 (Trautz and Weizels give 81·2). Both gases satisfy the Sutherland formula. For comparison purposes the viscosity coefficient of air was measured and good agreement found with existing data. Corrections are now given for previous viscosity measurements for hydrogen, oxygen, helium, argon, carbon monoxide and ethylene. The present data are applied to Kuenen's formula, and its utility discussed. The latter formula is not found to give a satisfactory solution of the viscosity problem, and the attempt has been made to explain the behaviour of gases by the assumption of polymers of simple molecules, since the attraction term and its temperature dependence may be derived by application of the laws of chemical dynamics employing van Laar's modified form of the equation of state. This presentation has afforded steps towards a qualitative idea of gaseous viscosity. H. H. Ho.

1732. *Notes on the Fundamental Mechanical Equations of Statistical Mechanics.* **G. Krutkow.** (Zeits. f. Physik, 36. 8. pp. 623–627, 1926.)—In statistical mechanics the general assumption is made that the external parameters a, which, together with the generalised coordinates and momenta, determine the phase of the mechanical system, only occur in the potential energy. The author now shows that the free system ($a \pm o$) must also be considered in addition to the bound system ($a =$ const.), otherwise false results are obtained. The paper concludes with a brief discussion of possible changes in statistical mechanics. H. H. Ho.

1733. *Work and Kinetic Energy in Energetically Preferred Inertial Systems.* **O. Heimstädt.** (Zeits. f. Physik, 36. 11–12. pp. 940–948, 1926.)—The author describes "energetically preferred" inertial systems as cosmic systems of reference in which the mobile masses possess the energy of their astronomically established motion. The conception of work done as applied to terrestrial acceleration processes, which for small changes of motion occurs parallel to the earth motion, must be extended for large differences of energy. It follows from the energy principle that the requisite potential energy for the execution of changes of motion passes over to the quicker moved masses. The rotations of bodies or masses are shown to involve only centripetal forces in energetically preferred inertial systems which bring about a direct exchange of the different kinetic energies of the masses concerned. It is also shown that the usual relativity treatment of rotation processes by classical mechanics (with centrifugal forces as consequences of rotation) is in contradiction with the gravitational hypothesis. H. H. Ho.

1734. *A Contribution to the Study of the Formation and Propagation of Vortex Rings in Air.* **C. Sadron.** (J. de Physique et le Radium, 7. pp. 76–91, March, 1926.)—The present paper contains an experimental study of the formation and propagation of vortex rings, and compares the results obtained with those of previous investigations. Part I comprises the qualitative examination of the mechanism of ring formation, and the quantitative study of the laws of its propagation. From the former the author concludes that a suction component is present which causes the rotation of the ring as it emerges from the apparatus, in contrast to the view of Brillouin, who assigns the cause to gas friction on the walls of the orifice. This suction component is produced in general when a discontinuous solid is immersed in a fluid having a translation velocity (*e.g.* vortices produced by oars). The expression, $t = as^2 + bs$, has been derived where s is the necessary length of path, t the time, a and b constants. The motion is found to be retarded from the start, a result in accord with Bouligand's mathematical theory, but contrary to Ball's experiments. The study of the enlargement of the ring is made in Part II by means of experiments on the combustion of bubbles of phosphine (PH_3). By photographic means the displacement law above has been verified for the greater part of the path, while the trajectory of the rim of the ring has been shown to possess the form, $s = k \log r/r_0$, where r is the diameter of the ring, thus confirming Belot's views. This widening is explained by the Magnus-effect of air upon the rotating ring, which also accounts for the characteristic deformation of the ring in a transverse current. Part III is devoted to a mathematical study of the subject based on Bouligand's theory which rejects the classical fluid dynamics and treats the vortex ring as a system with 4 degrees of freedom. The experimental results are shown to be in agreement with the theoretical conclusions. H. H. Ho.

1735. *A Thermionic Valve Method of Measuring the Velocity of Air-currents of Low Velocities in Pipes.* **J. A. C. Teegan.** (Phil. Mag. 1. pp. 1117–1120, May, 1926.)—A fine platinum wire stretched across the tube was connected in parallel with a resistance in the filament circuit of a thermionic valve. Change in its resistance due to cooling in the stream of air passing along the pipe will alter the filament current, and consequently the anode current. By calibration, these variations can be used to measure the velocity of the stream. W. G. B.

1736. *Experiments on the Magnus-Effect.* **Turpain and B. de Lavergne.** (Comptes Rendus, 182. pp. 925–927, April 12, 1926.)—Three different arrangements are described for measuring the Magnus-effect. (1) A cylinder of cardboard provided with spindles sliding on glass rails. (2) Two spheres of celluloid with wooden axles on which is wound the same suspension but in opposite senses. On being allowed to fall, the spheres separate from each other and diverge from the vertical. (3) A celluloid sphere is surrounded by a ring of tin plate. The axis ends in a needle-point and needle's eye. This is suspended in a triphase field and by burning the thread is allowed to fall on a smoked concave mirror. The rotation speed of the spinning ball is obtained stroboscopically, and on reversal of the field the separation of the traces gives the Magnus-effect in a current of air. J. E.

1737. *Aerodynamics of Windmills.* **Amans.** (Comptes Rendus, 182. pp. 841–843, March 29, 1926.)—Describes experiments on the effect of inclination of the wind stream and of blade twist on the performance of screws, with particular reference to windmill vanes. J. W. T. W.

1738. *The Motion of Two Spheres in a Viscous Fluid.* **Margaret Stimson and G. B. Jeffery.** (Roy. Soc., Proc. 111. pp. 110–116, May 1, 1926.)—The motion set up in a viscous fluid, at rest at infinity, by two solid spheres (equal or unequal) moving with equal small constant velocities parallel to their line of centres is investigated mathematically. The solution is based on the determination of the Stokes stream-function for the motion of the fluid, and from this the forces necessary to maintain the motion of the spheres are calculated. J. S. G. T.

1739. *A Transformation of the Problem of Neumann.* **S. Zaremba.** (Comptes Rendus, 182. pp. 1129–1130, May 10, 1926.)—*On Continuity of Order Zero in Hydrodynamics.* **G. Bouligand.** (*Ibid.*, pp. 1130–1131.)—A vector theorem and a physical interpretation. W. G. B.

1740. *Chart for the Calculation of Stream-lines.* **A. Closterhalfen.** (Zeits. Math. u. Mechanik, 6. pp. 62–70, Feb., 1926.)—A chart, consisting of squared and semi-logarithmic paper, which shortens and systematises the calculations involved in the determination of approximations to the stream-lines for two-dimensional, and for axially symmetrical, flow of a fluid past given boundaries, is shown, and the method of using it is explained. It is not possible to give an abstract, but it is claimed that its use saves quite two-thirds of the time of the older methods. W. G. B.

1741. *Time and Chance.* **N. Campbell.** (Phil. Mag. 1. pp. 1106–1117, May, 1926.)—Very general considerations indicate that a revision of classical conceptions of time is necessary. The view is suggested that time is a statistical conception; that while individual neighbouring events have a definite time-order, any temporal magnitude, such as velocity, interval, or frequency, is significant only with regard to statistical aggregates, and represents a probability of transition characteristic of the individual elements. The bearing of this suggestion upon outstanding problems is considered: (*a*) The lack of "reciprocity" in the interaction of an atom and charged particle (Bohr); (*b*) the interaction between matter and radiation, and the conflict between quantum and wave theory; (*b*) quantum mechanics, with special reference to the work of Heisenberg. In no case is any definite theory offered, but it is argued that a theory on these lines must be physically possible, while the mathematical possibility can be discussed only by those more skilled in analysis. AUTHOR.

1742. *Chance and the Formulæ of Laplace.* **Mirimanoff.** (Comptes Rendus, 182. pp. 1119–1121, May 10, 1926.)—The author considers a series of selections permitting two opposite events of constant probability respectively, and critically examines the attempts which have been made to evaluate the probability and the errors involved. In particular the investigations of Rayleigh, Nekrassoff, and Markoff are referred to. (**Errata,** *ibid.*, p. 1456, June 28, 1926.) H. H. Ho.

1743. *Reticular Distances in Crystals.* **I. Ranzi.** (N. Cimento, 3. pp. 135–143, March, 1926.)—Measurements, by X-rays method, of the variations in the equidistance of a family of reticular planes in rock-salt and calcite, under the action of a compression normal to these planes. A. D.

1744. *Crystal Structure of Catechol.* **W. A. Caspari.** (Chem. Soc., J. pp. 573–577, March, 1926.)—X-ray photographs have been taken of catechol by the rotating crystal method. The axial ratios should be written 1·6086 : 1 : 0·5114 and not 1·6086 : 1 : 1·0229 as given by Beckenkamp [Z. Kryst. Min. 33. p. 599 (1900)]. The unit cell contains eight asymmetric molecules, and is devoid of intrinsic symmetry. The dimensions of the cell are: $a = 17 \cdot 46$, $b = 10 \cdot 74$ and $c = 5 \cdot 48$ Å. T. H. P.

1745. *Isomorphism of the Oxides of Lead and Tin.* **G. R. Levi** and **G. Natta.** (N. Cimento, 3. pp. 114–134, March, 1926.)—A discussion of the results obtained by Dickinson and Friauf [Am. Chem. Soc., J. 46. p. 2457, 1924]. As these differ from Levi's [see Abstract 786 (1925)], the authors carried out a further series of experiments which appear to confirm their previous conclusions. Numerical results are given in five tables. E. F.

1746. *Solidity and Plasticity of Bismuth Crystals.* **M. Georgieff** and **E. Schmid.** (Zeits. f. Physik, 36. 9–10. pp. 759–774, 1926.)—The (111) face is the best cleavage and slip surface in bismuth, and the [10̄1] direction the best slip direction; these are the most thickly occupied plane and direction in the bismuth lattice. An unstretched monocrystal bismuth wire breaks in tension when the critical normal stress of 324 g./mm.^{2} perpendicular to the slip plane (111) is reached. Thus the tensional strength is essentially a function of the orientation of this surface in the wire. The limiting normal stress is independent of the temperature between − 80° and + 20° C. The commencement of distinct plastic stretching (elastic limit) corresponds to a definite critical shearing stress in the slip plane; this stress drops linearly from 221 g./mm.^{2} at 20° to 101 g./mm.^{2} at 200° C., and then remains constant nearly to the melting-point. Whether a bismuth crystal stretches plastically or is brittle depends on the position of the crystal lattice in the wire; if the angle between the slip plane and the axis of the wire is greater than 55° 42′ the crystal breaks without any plastic stretching, while if the angle is less than this it stretches plastically before breaking. H. N. A.

1747. *The Arrangement of the Atoms in the Tetragonal Crystals of the Mercury Halogen Compounds Hg_2Cl_2, Hg_2Br_2, Hg_2I_2. Calculation of the Optical Double Refraction of Hg_2Cl_2.* **E. Hylleraas.** (Zeits. f. Physik, 36. 11–12. pp. 859–896, 1926.)—The Debye Scherrer method was employed, and it was found that the lattices of these compounds contain two face-centred Hg lattices and two faced-centred halogen lattices, which, retaining the ditetragonal bipyrimidal symmetry, are shifted with respect to each other along the tetragonal axis. A figure in the original paper shows the relative positions of the atoms. The double refraction of Hg_2Cl_2, which is remarkable for the high values 2·6 for the principal refractive index of the extraordinary ray, and 2·0 for the ordinary, has been calculated for the above structure, and the values found agrees with those observed if it is assumed that the majority of the resonance electrons belong to the negative chlorine ion. The double refraction depends very much on the shift of the atoms in the lattice, and this makes it possible to determine the parameter very accurately. H. N. A.

1748. *Experiments on the Variation of the Angles of Crystals during Growth.* **E. S. Hedges.** (Chem. Soc., J. pp. 791–799, April, 1926.)—The experiments are a continuation of the work of H. Miers, and the goniometer devised by him, which permits the measurement of a crystal during growth, is employed. The vicinal faces were measured in crystals of sodium potassium tartrate, magnesium sulphate, diammonium hydrogen phosphate and sodium chlorate, and it was found that the number of faces undergoes an initial increase with time followed by a decline. There are continual and rapid changes in the positions of the images, generally by replacement, but in certain cases by continual progression. A method has been devised for obtaining the true positions of the ideal cube faces of sodium chlorate, even when they are absent, from observations of the vicinal faces. With slow growth the crystal approximates closely to the ideal form, and with careful control perfect cube faces were developed. Some of the experiments made support the theoretical explanation of vicinal faces suggested by Miers. H. N. A.

1749. *An Atomic Picture of Duralumin and its Crystal Structure.* **R. J. Anderson.** (Frank. Inst., J. 201. pp. 465–483, April, 1926.)—Gives a summary of the X-ray data applying to the elements in duralumin and to $CuAl_2$, describing their space lattices. Finds that the space lattice of duralumin is substantially identical with that of aluminium, the parameters being the same for aluminium and for duralumin with about 4 % of copper; about 6 % of copper diminishes the lattice slightly. It is considered that the aluminium atoms take up valence electrons from the copper atoms, and that the aluminium ions produced are much larger than the copper ions. A certain number of the latter are able to displace aluminium in the lattice without distorting it or reducing its parameter.

Reproductions showing the diffraction patterns of cold-rolled, of annealed and slowly cooled, and of quenched and aged duralumin are given. In the first case the lines are smooth and straight, showing that the crystal grains are small; in the two latter cases the lines are "dashed," indicating recrystallisation and grain growth; stretching straightens the wavy dashed lines. The alloy is considered as a solid solution, and hardening due to ageing is discussed on the basis of diffusion in the solid state. H. N. A.

1750. *On the Electrostatic Potential Energy and the Rhombohedral Angle of Carbonate and Nitrate Crystals of the Calcite Type.* **S. Chapman, J. Topping** and **J. Morrall.** (Roy. Soc., Proc. 111. pp. 25–56, May 1, 1926.)—A sequel to and extension of a paper by W. L. Bragg and S. Chapman on the same subject, giving the detailed results and method of calculation. In stable equilibrium the ions will adopt a grouping which renders the total potential energy a minimum, and the change in potential energy corresponding to a small first-order change in the grouping will be zero (of the second order). It is shown that it is possible to neglect any change in the potential energy of the repulsive forces and consider only the electrostatic potential energy. This is calculated on the assumption that $CaCO_3$ (calcite) is built up of O^{--} ions, Ca^{++} ions, and C^{++++} ions arranged in the general manner which has been deduced from the X-ray data. The results are indicated graphically by equipotential lines in a diagram, and so-called configuration curves are drawn on the same diagram; where a configuration curve touches an equipotential line a state of maximum or minimum potential energy is indicated. The results are used to determine the theoretical value of the rhombohedral angle in a series of carbonate crystals of the calcite type and in sodium nitrate, or, alternatively, to deduce from the angles the distance between the electrostatic centres of the O^{--} ions in the CO_3 and NO_3 groups. H. N. A.

1751. *The Forces of Chemical Affinity. A Study of Crystal Structure in the Light of the New Atomic Models.* **A. C. Crehore.** (Phil. Mag. 1. pp. 786–827, April, 1926.)—The atomic models referred to in the title are those described by the author in previous papers [Abstract 1821 (1925)], and not those of Rutherford and Bohr. The paper deals with the simple cubic lattice, the face-centred cubic lattice, the diamond lattice, the model of the carbon atom described in 1922 being employed, and concludes with a discussion of the hydrogen lattice, in which it is shown that if and when the lattice form of solid hydrogen can be determined a possible form, according to the author's theory, may be cubic, about $4·36 \times 10^{-8}$ cm. on an edge, with groups of four H atoms at the corners in the form of a regular tetrahedron of $0·58 \times 10^{-8}$ cm. on an edge. H. N. A.

1752. *The Statistical Mechanics of Assemblies of Ionised Atoms and Electrons.* **R. H. Fowler.** (Phil. Mag. 1. pp. 845–875, April, 1926.)—Refers to a series of papers by Darwin and Fowler, in which statistical mechanics is applied systematically to assemblies of isolated systems, and in particular to a final paper by Fowler, which includes imperfect gases and attacks the properties of matter at the temperatures and densities occurring in stars [Abstract 565 (1926)]. Describes a variant of the treatment of Urey and of Fermi, which the author and Guggenheim have used in an extensive series of calculations for stellar interiors. Gives a formal specification of atomic dissociation theory in terms of ions and free electrons; specifies the energies of the various atoms in the different stationary states of their various stages of ionisation and the *weights* of these states. These are required unaltered in any form of the theory; the recent work of Pauli is applied in this connection. Planck's suggestion [Abstract 790 (1925)] that it ought to be possible to derive the proper form of the partition function directly and solely from the phase integral of Gibbs, with suitable quantum theory modifications, and his treatment of the phase integral in this sense are investigated and generalised. It is shown that his theory then leads to results of very much the same form as that of Urey and Fermi, but the arbitrary simplification it contains probably leaves it almost as far from the real truth. The theories may perhaps be accepted with some confidence for hydrogen-like atoms with one electron, and have been applied by Fowler and Guggenheim to atoms with more than one electron. H. N. A.

1753. *The Ehrenfest Model of the H-Curve.* **K. W. F. Kohlrausch** and **E. Schrödinger.** (Phys. Zeits. 27. pp. 306–313, May 15, 1926.)—Describes a series of "drawings" by means of which numbered balls are shifted from one of two urns to the other every time their number is drawn. The difference between the number of balls in the two urns, starting with one hundred in one and none in the other, is plotted against the number of drawings; it falls rapidly towards zero, and fluctuates about that value by small amounts. The paper deals theoretically with the problem for the stationary state after a large number of drawings, and approximate formulæ are obtained for the non-stationary state at the commencement of the drawings. The results of the drawings are compared with the theory. H. N. A.

1754. *Some Modern Aspects of Physical Research.* **A. Ewing.** (Roy. Soc. Edinburgh, Proc. 46. 1. pp. 1–8, 1925–1926.)—The speaker glances back on the progress made in recent years in pure and applied science, and reviews the more striking results which have been obtained in astronomy and atomic physics. W. S. S.

1755. *Periodic System of the Chemical Elements in the Light of Atomic Structure.* **R. Swinne.** (Zeits. techn. Physik, 7. 4. pp. 166–180, and 7. 5. pp. 205–216, 1926.)—A critical, historical summary is given of the development of the arrangement of the chemical elements in a periodic system. Among the subjects treated are: Replacement of the atomic weight by the atomic number; explanation of the periodicity by arrangement of the electrons according to quantum numbers; distribution of the electrons in groups characterised by different quantum symbols; unoccupied positions in the system; and the existence and properties of the elements to be expected beyond uranium, etc. T. H. P.

1756. *Energy Fluctuations and Quantised Vibrations.* **P. Ehrenfest.** (Zeits. f. Physik, 34. 5–7. pp. 362–373, 1925.)—The energy fluctuations to be expected in the radiation field are calculated on the basis of the superposition of quantised free vibrations; they are smaller than Einstein calculated. It is explained how this arises. Einstein calculates the energy fluctuations in black-body radiation on the basis of Planck's law. His result is that these fluctuations are incompatible with waves. But

Planck's law is derived from the wave theory on the basis of Planck statistical mechanics of energy levels. Hence a contradiction apart from the nature of light. Einstein assumes that the entropies of the different volume-elements are purely additive, but this may not be so in the special case of the superposition of waves. It is also important to notice that the energy fluctuations of a volume-element will have different values when calculated as the fluctuation in time of one element or as the fluctuation from a mean of several elements at the same time. The fluctuation is calculated on the basis of a Planck lottery, (*a*) considering the distribution in free space of volume V of the energy, measured at the same instant each day during many days; (*b*) considering a portion v of V, well inside V, and measuring the energy $e(t)$ of v each day at time t during many days [similar to (*a*), but considering only a small portion of V]; (*c*) considering the variation of $e(t)$ during one day. If V tends to infinity, Einstein's formula is unaffected, while the present formula (*b*) converges to the value calculated from non-quantised "classical" vibrations. Energy fluctuations are also to be expected in the volume-elements of the crystal lattice, and the same methods may be applied as to radiation. A. C. M.

1757. *The Energy Law and Rydberg's Principle.* **F. London.** (Zeits. f. Physik, 36. 9–10. pp. 775–777, 1926.)—In the quantum mechanics of Born, Heisenberg and Jordan [see Abstract 1229 (1926)] for the proof of the conservation law, $\dot{H} = 0$, the existence of a term matrix, W, which embodies the Rydberg Combination Principle, is postulated. The author shows that the law can be established on the basis of the canonical equations and the quantum condition $pq - qp = (h/2\pi i)1$, alone. In the proof, a general form of differentiation is employed of which Born's differentiations of the first and second kinds are "contractions" in the sense of tensor analysis. W. S. S.

1758. *Small Free Oscillations of an Enumerably Infinite System.* **A. Wintner.** (Zeits. f. Physik, 36. 9–10. pp. 778–781, 1926.)—A mathematical treatment is given of the oscillations about an equilibrium position of an enumerably infinite system, linear equations of motion being assumed. The conditions imposed are not such as to exclude a band spectrum from the solution. Despite this fact, a canonical representation of the solution is obtained in terms of the line-spectra corresponding to all the finite systems comprised in the actual infinite system (Abschnitten). W. S. S.

1759. *Theory of Excitation of Atoms by Collision.* **L. Nordheim.** (Zeits. f. Physik, 36. 7. pp. 496–539, 1926.)—A mathematical paper not permitting of a short abstract. A correspondence relationship is suggested between the mechanical disturbances and the probabilities of "Quantensprüngen" (quantum jumps) at the collision of atoms. A mathematical theory on these lines is developed. This theory gives qualitative explanation of many experimental observations previously unexplained.

A. B. W.

1760. *Rotation Spectra in the New Mechanics of Quanta as treated by the Calculus of Matrices.* **L. Brillouin.** (Comptes Rendus, 182. pp. 374–376, Feb. 8, 1926.)—Heisenberg [see Abstract 45 (1926)] and Born and Jordan [see Abstract 447 (1926)] have recently proposed an entirely new method of formulation for quantified mechanics which the present author now applies to rotation processes in order to derive the Deslandres formulæ for vibration and rotation spectra. Section 1 deals with rotation, modifications of Born's treatment being introduced. Section 2 is concerned with vibration and rotation, the two kinds of spectra arising from a combination of the two movements. Experimental verification has been found for certain of the results. The paper is entirely mathematical. H. H. Ho.

1761. *The Time of Excitation of Hydrogen Atoms.* **J. S. McPetrie.** (Phil. Mag. 1. pp. 1082–1094, May, 1926.)—Previous workers on the light-emission from a beam of positive rays have assumed that the time during which an electron remains in an excited orbit is negligible, and their aim has been the determination of the time of emission. The present paper has for its object the determination of this time of excitation, and it is shown to be comparable with the time of emission. One method used gives the value of about 10^{-8} sec. for the time of excitation of the H_β line of the Balmer series of hydrogen. A slightly different method is described for the determination of the values of both the times of emission and excitation. They are found to be approximately 2×10^{-8} sec. and $7 \cdot 5 \times 10^{-9}$ sec. respectively. The slightly different results obtained for the time of excitation by the two methods are discussed, and reasons given for the small discrepancy. AUTHOR.

1762. *Electronic Orbits on the Relativity Theory.* **O. R. Baldwin** and **G. B. Jeffery.** (Roy. Soc., Proc. 111. pp. 104–110, May 1, 1926.)—The possible circular orbits of a charged electron about a charged nucleus in accordance with the theory of relativity are discussed. An exact solution is, at present, impossible, and the investigation is accordingly based on the assumption that the nucleus may be regarded as fixed in position, the effect of reaction on the nucleus being neglected. The possible orbits deduced have a superficial resemblance to Bohr's quantised orbits.

J. S. G. T.

METEOROLOGY AND GEO-PHYSICS.

1763. *Statistical Investigation regarding Anomalies of the General Circulation of the Atmosphere.* **A. Defant.** (Meteorolog. Zeits. 43. pp. 121–132, April, 1926.)—A general review is provided of statistical work, particularly correlation coefficients dealing with monthly and yearly means of pressure, temperature, precipitation, and less frequently wind. Two lines of approach are considered: (1) simultaneous changes, and (2) non-simultaneous changes of meteorological elements at different parts of the earth. The former provides methods of examination of the general circulation of the atmosphere, while the latter is of prognostic value for long-period forecasts of weather conditions. Among earlier work considered is that of Schedler, Wiese, Meinardus, and the author on relations for the North Atlantic, of Walker for the North Pacific, of Mossmann for the South Pacific, and of Walker and Exner for the northern hemisphere and for the whole globe, as illustrations of the simultaneous changes. For the other kind of changes, investigations by Walker, Exner, Mossmann, Braak, Clough, Angenheister, Georgii, Wiese and Galle are summarised and applications of the results to the forecasting of monsoon rainfalls, winter temperature in Europe, and other factors examined. It is stated that the correlation method can at present give only the large general features but no deep insight into the method producing these changes. **R. S. R.**

1764. ***Atmospheric Diffusion shown on a Distance Neighbour Graph.*** **L. F. Richardson.** (Roy. Soc., Proc. 110. pp. 709–737, April 1, 1926.)—The atmospheric diffusivity in Fick's equation has been found by various investigators to increase from 0·2 to 10^{11} cm.^{2} sec.$^{-1}$ as the size of the cluster of diffusing particles increases from 10^{-2} to 10^8 cm. The effect is due to eddies of many sizes acting together. There is apparently no way of modifying Fick's equation in order to describe this phenomenon. But a new mathematical method is here developed in which, instead of thinking about concentration as a function of position, we think about q, the mean number of neighbours per length, as a function of l, their distance apart. Formal definition is given to this idea, and various properties of it are investigated. For simplicity only distributions on an unbounded straight line are considered, or projections of three-dimensional distributions on to the line. If the movement of concentration ν is described by Fick's equation,

$$\frac{\partial \nu}{\partial t} + u\frac{\partial \nu}{\partial x} = K\frac{\partial^2 \nu}{\partial x^2},$$

where t is time, x is distance, u is mean velocity, and K is diffusivity. Then it is proved that

$$\frac{\partial q}{\partial t} = 2K\frac{\partial^2 q}{\partial l^2}.$$

If, however, the diffusion is "non-Fickian," as in the atmosphere, then the former of these equations cannot be generalised, but the latter can, taking the form

$$\frac{\partial q}{\partial t} = \frac{\partial}{\partial l}\left\{F(l)\frac{\partial q}{\partial l}\right\}.$$

A discussion of existing observations shows that a rough average value is $F(l) = 0\cdot 6 l^{4/3}$ cm.^{2} sec.$^{-1}$ for the atmosphere, when l lies between 1 metre and 10 km. The diffusion of a lamina is worked out from these principles. The diagram obtained in this way exhibits the size of a cluster because it is proved that the standard deviation of the (l, q) area from its centre $l = 0$ is $\sqrt{2}$ times the standard deviation of the cluster from its centroid. Two methods are prepared for the observation of F(l) by balloons or smoke. Various allied topics are examined. **Author.**

1765. ***Acceleration and Aspect of Isobars at a Surface of Discontinuity in the Atmosphere.*** **F. M. Exner.** (Meteorolog. Zeits. 43. pp. 146–148, April, 1926.)—The author corrects an example given earlier [Abstract 1575 (1925)] in which a solution of movements of warm and cold fronts conflicts with wind and pressure laws. Equations are established for the slope of the surface of discontinuity and for its acceleration in the two cases where (1) cold air in the form of a wedge lies under warm air, and (2) cold air inclined to the ground lies over warmer air. Figures are given to represent the shape of the isobars at different levels for these cases. **R. S. R.**

1766. *The Measurement of Atmospheric Impurity.* **d'Arsonval** and **F. Bordas.** (Comptes Rendus, 182. pp. 823–825, March 29, 1926.)—The results obtained from measurements of atmospheric pollution in Paris during February, 1925, and the effects of this impurity upon public health, are discussed. A. W. L.

1767. *The Psychrometer Question.* **A. Svensson.** (Meteorolog. Zeits. 43. pp. 140–146, April, 1926.)—The author gives a formula for the ventilated psychrometer $x = f'(0\cdot 9742 + 0\cdot 000442t') - 596\,.\,10^{-6}H(t - t')$, where x is the vapour-pressure required, t and t' the temperatures of dry and wet bulbs, and f' the saturation vapour-pressure at t' °C and atmospheric pressure H. This holds over the ranges − 2·°96 to 26·°25 C for t, − 2·°78 to 22·°56 C for t', 0·°17 to 16·°66 for $t - t'$, and 4·5 % to 96·5 % for the relative humidity. The mean limits of error of observation are ± 0·12 mm. This approximates to $x = \eta f' - A\,.\,H\,.\,(t - t')$. Examination of several kinds of material surrounding the wet bulb leads to little difference for η, but the thickness, texture, flexibility and previous treatment of the substance are of importance. The author recommends a stocking-shaped cover for the thermometer bulb of the Assmann psychrometer, and these to be supplied by the maker to secure uniformity. The author in his formula allowed for radiation and ventilation, and thus $A \times 10^6 = 590 + \frac{a}{\sqrt{v}}$, where a is proportioned to the amount of radiation and v is the velocity of travel of the air. For the Assmann psychrometer this gives $A = 596\,.\,10^{-6}$. For unventilated thermometers not protected by radiative covers A is considerably larger. The Sondén's hygrometer is especially recommended for use, as it is based on the physical laws of mixed gases and gives results agreeing well with Regnault's historical values for vapour-pressures. R. S. R.

1768. *A New Registration of Temperature and Pressure in the Upper Atmosphere.* **E. Delcambre, P. Idrac** and **F. Geoffre.** (Comptes Rendus, 182. pp. 858–859, March 29, 1926.)—The authors describe a modified type of Dines balloon meteorograph, weighing 55–60 gms., and giving records on which 1 mm. corresponds with about 3° of temperature and 25 mb. pressure. A. W. L.

1769. *Humidity and Hoar-frost over the Arctic Ocean. Results from the "Maud" Expedition, 1922–1925.* **F. Malmgren.** (Geofysiske Publ. 4. 6. [20 pp.], 1926.)—Humidity was measured with a thermopsychrometer, a new instrument which consists of an Assmann aspiration psychrometer in which the thermometers are replaced by thermo-elements; the temperature is read from a separate thermometer, and the observations are computed from the formula and tables for the Assmann psychrometer. The difference in temperature between the wet and dry bulbs, obtained from the thermopsychrometer, is accurate to within ± 0·006°, which corresponds with an accuracy of about 2 % in the relative humidity at − 40°. The results of about 150 observations show that during the winter the relative humidity over ice (R_i) always keeps around 100 %, and that R_i is an inverse function of wind velocity, temperature and cloud amount. The author shows how these results are in full accordance with the special conditions in the Polar Sea, and that the relationship between temperature and humidity may be used to get the relative humidity for any winter month from the mean temperature. By this means the humidities obtained on the *Fram* expedition of 1893 to 1896 are corrected for faulty reduction of the observations of hair hygrometers. The *Fram* records, thus corrected, show that (1) the relative humidity over water, R_w, has a maximum in July and a flat minimum in winter; (2) R_i is a maximum in winter, but has a secondary maximum in July; (3) the daily periods of R_w from spring to autumn, and of R_i in spring and summer, show a minimum in the day, but in autumn R_i has its minimum at night; in winter the daily variations are small. Hoar-frost was measured by registering the amount deposited upon a cylinder suspended from one arm of a balance, equilibrium being maintained by a counterpoise and spiral spring on the opposite side. The diurnal and annual variations of hoar-frost are found to be similar to those for humidity. A. W. L.

1770. *Spectral Polarisation of Light from the Sky.* **N. N. Kalitin.** (Meteorolog. Zeits. 43. pp. 132–140, April, 1926.)—A spectrophotopolarimeter was devised to measure the degree of polarisation of the sky accurately and rapidly. Over the range 410–650 $\mu\mu$, thirteen parts were chosen for investigation. The results were classified into five main and eight subsidiary types according to the position of the maximum and minimum and the existence of one or more of these. In a table relative values for the polarisation in the different parts of the spectrum are given for cloudless skies, with various altitudes for the sun and with or without snow on the ground. It was found that in about 40 % of cases with or without snow the polarisation increases from short to long wavelengths, changing regularly with snow on the ground, but with a weak minimum at 540–570 $\mu\mu$ for no snow. The results are in agreement with those of Hockel and of Hauers. When visibility is bad, the maximum polarisation occurs for short waves and the minimum for long waves, which agrees with Cornu's results obtained subsequent to the Krakatoa eruption, when large amounts of volcanic dust existed in the atmosphere. With increase in solar height the difference between the polarisation in the red and blue decreases in such a way that with the rise of the sun the increase of polarisation in the red is a maximum, but the general distribution of polarisation across the spectrum is unchanged. These results confirm those of Piltschikoff. Ideal turbid media should give equal polarisation over the whole spectrum, but this was found on only 8 % of occasions. When clouds are present the distribution becomes complicated by the existence of particles of various sizes. It was also shown that when cirrus is forming, but not yet visible, there is an increase of polarisation from short to long waves. R. S. R.

1771. *Measuring Sun Rays.* **C. G. Abbot.** (Roy. Meteorolog. Soc. J. 52. pp. 1–6, Jan., 1926.)—Evidence in favour of the reality of small and irregular changes in solar radiation is adduced from the relationship between the observed values of the solar constant and visible solar phenomena. These fluctuations seem to be correlated in a complex way with following changes of weather, and radiation measurements have been taken by Clayton as a basis for making weekly forecasts for the Argentine and North America; the forecasts are in general rather satisfactory, but occasionally the forecast and event are opposite in all details. A very high degree of accuracy in the measurement of the solar constant is required in making these forecasts, and they may be improved when an additional solar radiation station has been established in the eastern hemisphere. A. W. L.

1772. *So-called Volcanic Earthquakes.* **T. A. Jaggar.** (Science, 63. pp. 414–415, April 23, 1926. Paper read before the Am. Assoc., Kansas City, Dec., 1925.)—The author attacks some of the older ideas concerning earthquakes, and considers that heat and magma are the conditioning causes of big earthquakes. Gradations of volcanicity across country involving both time and place are cited in support of his view. A number of causes which may give rise to this conditioning process are quoted. R. S. R.

1773. *New York City as a Field for Earthquake Study.* **C. A. Reeds.** (Science, 63. pp. 415–418, April 23, 1926.)—Details are given of the characteristics of longitudinal, transversal and long waves in seismic disturbances and the methods by which they may be differentiated. A full statement of the geological structure of New York City and of adjacent districts shows that considerable earth faults must have been produced during the glaciation period in North America, these being greatest near Quebec, but negligible near New York. The post-glacial uplift of the land is not yet ended, as indicated by numerous slight earthquakes in this area during the last four centuries, and consequently, while New York is an aseismic area, it offers an excellent field for the instrumental study of distant and nearby earthquakes. R. S. R.

1774. *Radio-activity of Potassium and the Heat of the Earth.* **A. Holmes** and **R. W. Lawson.** (Nature, 117. pp. 620–621, May 1, 1926.)—The influence of the disintegration of the uranium and thorium series of elements on the heat of the earth is great, and an estimate is now made of the energy available due to the presence of the much less active but much more plentiful elements, potassium and rubidium. No direct estimates of the life of these elements are available and their activities are not very exactly known. From consideration of the experimental data, the half-value period of rubidium is assumed to be 10^{11} years and for potassium 15×10^{11} years. It is then shown that the available energy for many rocks has to be raised by about 30 %, and it is found that 15 km. of average granite will supply the heat lost by the surface of the earth. This agrees exactly with Jeffrey's estimate of the thickness of the granitic layer derived from seismic data. The investigation is stimulated by the idea that the extensive intrusions of granite of Pre-Cambrian age might be explainable in terms of a greater influence of potassium at that time. A. Wh.

ASTRO-PHYSICS.

1775. *Zone + 45° of Kapteyn's Selected Areas: Parallaxes and Proper Motions.* **O. J. Lee.** (Yerkes Obs. Publ. 4. 4. [67 pp.], Aug., 1925.)—A study of 310 plates taken of Kapteyn's Selected Areas, 20 to 43 inclusive, with the 40-in. Yerkes refractor, which produce a catalogue of parallaxes and proper motions of 1041 stars between photographic magnitudes 6·7 and 14·7. A plate is given of the star field in selected area 41. The author discusses various errors. The field given by the Yerkes refractor on a 8 by 10-in. plate is 35′ by 45′; within a circle of 15′ radius no extra-focal deformation is seen; outside this, stars of magnitude 9–11 show slight elongation, which is uniformly present, and below magnitude 12½ no deformation at all; the intermediate stars, located at the ends and corners of the plate, are difficult. The measuring instrument is sensitive to changes of temperature, and commercial photographic plates are almost always concave on the film side. In the reduction of the measures, he discusses whether linear or quadratic terms should be included. For the magnitude error due to the discussion of stellar images of different sizes, he considers Kapteyn's suggestion of an isomagnitude plate, but decides that, in the main, indirect methods are more satisfactory; in the large range of 8 magnitudes of these 1041 stars the magnitude error is not, however, outstanding. From the parallaxes and proper motions of these stars, he finds evidence that many are feebly luminous because they are small, and therefore for such faint stars no reliable reduction to absolute can be made from these tables. Intrinsically large and small stars are more thoroughly mixed than has been supposed generally. In the 24 areas under discussion no large proper motion has been found, and though stars of from 7 to 13 magnitudes are represented, the three stars having most motion are faint (magnitudes 12·37, 12·38 and 11·12). There is an increase in average proper motion with increasing galactic latitude from the 11th magnitude on. The observed parallaxes in these areas show that our system is nearer to the Cygnus part of the Galaxy than to the opposite side. The author uses the negative parallaxes (about 400) to derive the probable error. He gives diagrams comparing his parallaxes with Schlesinger's Yale List, which have also been analysed by groups in galactic coordinates; and though the two groups differ in average by 6 or 7 magnitudes, he concludes that both lists have sounded different depths within certain right ascensions, "and have mapped the same irregularities in stellar distances." A. S. D. M.

1776. *Large Proper Motion Faint Stars in Selected Areas. First List.* **H. Knox-Shaw.** (Roy. Astron. Soc., M.N. 86. pp. 342–344, March, 1926.)—The Radcliffe Observatory (Oxford) programme includes Selected Areas Nos. 1–115 and twenty areas of the Special Plan. Two series of plates are taken at epochs not less than ten years apart; the first series have 30-min. exposures and are kept undeveloped until the second epoch. The second series have similar exposures, but are twofold, the first being exposed with the film side turned to the objective, the second with the glass side. These give two (largely independent) values of the stars' proper motions, from which, so far, have been deduced the probable errors in proper motion: in R.A., ± 0″·0055; in Dec., ± 0″·0058. The work on ten areas has been computed, and in them thirteen stars have been found with large proper motions ranging from 0″·100 to 0″·301 per annum. A table of these is given. A. S. D. M.

1777. *Photographic Studies of Nebulæ.* **J. C. Duncan.** (Mt. Wilson Observat. Contrib. No. 303. Astrophys. J. 63. pp. 122–126, March, 1926.)—Studies of the form and structure of diffuse nebulæ, both luminous and obscure, from photographs made with the 100-in. and 60-in. reflectors. Half-tone reproductions are given of photographs with the Hooker telescope of the dark nebula Barnard 86 and of uncatalogued nebulosities near α and γ Cygni. The nebulosity between α Cygni and the America nebula is found to possess a number of interesting features. Two nebulous stars are found in the neighbourhood of γ Cygni. The spectra of one of these and of H.D. 195255 situated at the edge of a dark marking in the nebula east of γ Cygni are of late B-type. The spectrum of H.D. 199178, situated on the line dividing a bright nebula from a dark one, is of type G5, and its spectroscopic parallax, determined by Adams, is $0''\cdot015$. AUTHOR.

1778. *Reduction of Thirty-nine Astrographic Zones to the International Photographic Scale.* **F. H. Seares** and **Mary C. Joyner.** (Mt. Wilson Observat. Contrib. No. 305. Astrophys. J. 63. pp. 160–176, April, 1926.)—Photographic magnitudes on the international scale corresponding to the values of log N_m(N_m = number of stars per square degree brighter than *m*) given for thirty-three zones in Table XV, Mt. Wilson Contrib. No. 301 [Abstract 945 (1926)] were interpolated from Table XVII of that paper. Together with the equivalent scale-readings or provisional magnitudes used to express the brightness of the stars, the interpolated magnitudes provide for a calibration from three to five points on the scales of the individual zones. The calibration was extended to other scale-readings for which counts are available by comparing mean densities for entire zones to successive limits of scale-reading with the adopted mean distribution of stars for all latitudes together. Final results are in Table IV, which also includes data for six Oxford zones for which counts have recently been published. Although the calibrations refer to zones as a whole, the residuals in limiting magnitude for different galactic latitudes given in Table I indicate that in many cases the calibrations are directly applicable to small parts of a zone. These residuals are not, however, a final test of consistency in the scales, because both errors of reduction and irregularities in stellar distribution contribute to their progressive character. AUTHORS.

1779. *Corrections to Declination System of Boss's Preliminary General Catalogue.* **H. Raymond.** (Astron. J. 36. Nos. 857–858. pp. 129–138, March 22, 1926.)—An extension of a preliminary study of the systematic corrections to the Boss proper motions [see Abstract 506 (1925)]. The author adds 34 to the original 27 catalogues, 17 out of the 61 being regarded as absolute, having been reduced with self-determined refractions. Of his additional catalogues he corrects 26 for refraction by comparing the catalogues in pairs or multiples, some from a northern hemisphere, some from a southern, of about the same epoch. Tables give a list of these catalogues and corrections to the *Preliminary General Catalogue* (*P.G.C.*) as given by the individuals. Instead of reducing these 61 catalogues to the revised system, the author follows Kapteyn's method given in B.A.N. 1, 169, 1923. He discusses the declinations issued by Pulkova, Greenwich and the Cape, and gives the corrections to *P.G.C.* at the equator by these series. They are not, however, homogeneous, the most notable breaks coinciding with changes in method or personnel. He finds that in Pulkova the chief source of uncertainty is due to the zenith term; in Greenwich to the change of instrument (mural to transit circle, etc.) and to flexure; in the Cape, which is the least satisfactory, to non-homogeneity by the Cape Jones circle and the non-reversible circle, with Gill's instruments. The probable errors for the corrections to *P.G.C.* of the Pulkova and Greenwich solutions are about the same as those of the general solution, those of the Cape being about three times as great. A weighted mean is taken. The final values are somewhat smaller than some other recent determinations, and the reasons for the differences are discussed briefly. A. S. D. M.

1780. *On Continuous Hydrogen in Spectra of Class A Stars.* **Ch'ing-Sung Yü.** (Lick Observat., Bull. 12. No. 375. pp. 104–121, 1926.)—Huggins observed in Vega and other A stars a rather sudden fall of intensity of the "background" spectrum at about the end of the Balmer series. Such has been observed in the laboratory on the violet side of sodium, of potassium, and, in one instance, of hydrogen. In heavenly bodies it has been observed in the sun and in planetary nebulæ [see Abstract 2392 (1922)], and in hydrogen stars. The author has made an intensive study of the ultra-violet region in 91 stars of Classes B5 to A9, brighter than the 4th photographic magnitude, north of Dec. −18°, and of zenith distance 60° or under, by means of slit and slitless spectrographs, taking as a standard of comparison the BO star, ζ Ophiuchi. Seed 23 plates were used for the 131 spectrograms, which were measured on the Hartmann wedge microphotometer, yielding apparent intensity graphs from which, with the aid of the comparison spectrum, the stellar energy curves are obtained. These show that the continuous absorption begins on the redward side of the last of the Balmer series, so that the continuous and the line spectrum overlap. The absorption increases rapidly up to the last Balmer line, and beyond this remains practically constant, and in this the author's observations do not agree with Milne's theory [Abstract 2458 (1925)]. The intensities at the centres of the Balmer series lines are about the same. The amount of the continuous absorption varies from star to star with the strength of the line absorption. Plates are given of apparent intensity graphs (both slit and slitless observations) and the deduced stellar energy curves for certain typical stars and for the sun out of focus; also a table of the effective temperature of 69 stars based on an assumed temperature of 22000° K for ζ Ophiuchi. A. S. D. M.

1781. *Origin of Radiant Energy of Fixed Stars.* **H. Fricke.** (Phys. Zeits. 27. pp. 326–332, May 15, 1926.)—The theory of a gradual cooling of the universe owing to the continued radiation of enormous quantities of energy into space is not borne out by observation. Geological researches appear to justify the conclusion that terrestrial climate, and therefore solar heat, have varied but little during a period of many millions of years. The theory rests on the unsatisfactory assumption of a radiation of energy into space in one direction only. The problem admits of a simple solution if we may assume an equilibrium of radiation between the stars and cosmic space. According to the old view, there is only a limited amount of energy available which should have been lost long ago by friction, and the attempt is made to postpone as long as possible the threatened stoppage and collapse of the universe by assuming the space or ether to be frictionless. The attempt is here made to conceive the passage of the cosmic bodies through the ether not as frictionless, but rather as motion through a resistent medium under the influence of a force, with transference of energy from the ether to the solid matter. The improbable conception of an absolutely intangible ether is not necessitated by observation and must be discarded. The author's deductions are largely based on Nernst's *Structure of the Universe in the Light of Recent Research,* Berlin, 1921. E. F.

1782. *Mass of Venus.* **J. K. Fotheringham.** (Roy. Astron. Soc., M.N. 86. pp. 296–300, March, 1926.)—In his provisional theory Leverrier used for the mass of Venus, expressed in terms of the mass of the Sun, the value 1/401847. Newcomb, in his *Astronomical Constants,* deduced a mass of 1/408000. An opinion has gained ground that Leverrier's value was nearer the truth than Newcomb's; and in a paper on "Greenwich Observations of the Moon" [see Abstract 1538 (1923)] Dyson and Crommelin applied to Brown's value of the great Venus term in the motion of the Moon a correction of 1/80th. In the present paper it is shown that the defects of Newcomb's determinations have been exaggerated, and that the mass of Venus is not much greater than he supposed. His result from observations of the Sun is strictly comparable with Ross's result from Mars, and combining their solutions we have: Mass of Venus = 1/406358 the Sun. M. A. E.

1783. *Velocities of Ions, Radiation Pressure in a Stellar Atmosphere and Ultra-violet Continuous Spectra.* **M. C. Johnson.** (Roy. Astron. Soc., M.N. 86. pp. 300–319, March, 1926.)—The ions composing largely the upper parts of a stellar atmosphere are subject to forces due to gravity, radiation pressure and electrostatic space charges. Generally the ions and electrons will tend to separate until the electrostatic force called into play sets up an equilibrium. In certain cases no equilibrium will be reached. This will apply to the elements He, Ca, Si, C, N and O in stars of effective temperature above 25,000°. In this case the atoms of these elements will move outwards through the outer layers of the star accompanied by an equal charge carried by electrons. Hydrogen will not move outward. The ultra-violet spectra of certain stars are interpreted in terms of electron captures by hydrogen. The electronic velocities may be due to thermal energy, photoelectric ejection, or convection currents. Extremely high electron velocities may be attained by the electrons moving outwards with the ions mentioned in the first part of the paper in the case of stars with an effective temperature above 25,000°. Captures in the case of this type of collision will be generally partial. A. Wh.

1784. *Radiative Viscosity.* **J. H. Jeans.** (Roy. Astron. Soc., M.N. 86. pp. 328–335, March, 1926.)—In the treatment of the figures of equilibrium of rotating masses, the assumption is made that the body rotates as if solid. It is well known that the effect of viscosity is not sufficient in most cases to make this true, but the transfer of momentum by radiation will introduce a factor which is described as "radiative viscosity" and which will have a profound influence on many problems. Numerically it will often be many times greater than ordinary viscosity. It is shown, however, that the action of radiative viscosity will not reduce the motion to one resembling that of a solid body. Radiation produced at or near the centre of a star will have little angular momentum and, as it travels outward, it will gain angular momentum at the expense of the outer layers. The ratio of angular velocity to mass will be nearly constant for a star. The genesis of binaries and spiral and planetary nebulæ will also be greatly affected by radiative viscosity. A. W.

1785. *Reflection Effect in Eclipsing Variables.* **A. S. Eddington.** (Roy. Astron. Soc., M.N. 86. pp. 320–327, March, 1926.)—In some eclipsing variables the reflection of the light of the bright by the faint component is considerable. The heat albedo of a star is unity. This follows from the fact that the condition of the surface layer of a star cannot effect the flow of energy from the dense interior. It would be expected that the luminous efficiency of reflection should be above 100 % if the radiation is absorbed and re-emitted as black-body radiation at the temperature of the reflecting star. The observations do not bear out this point, and it must be assumed that reflection takes place by scattering in the upmost layers of the stellar atmosphere. If the heat reflected in any particular direction is considered, the albedo at full phase is 17/16. A correction is also necessary of the ellipticity constant, to which has to be added 0·36 times the reflection coefficient. It is noted that the secondary often has hemispheres of unequal luminosity. Hence a correction for radial velocity measurements must be applied to make them applicable to the centre of the disc. A. Wh.

1786. *Absolute Motion of the Earth* **E. Esclangon.** (Comptes Rendus, 182. pp. 921–923, April 12, 1926.)—Three effects have been examined at Strassburg Observatory. The first is a sidereal apparent deviation of the vertical, deduced from horizontal pendulum observations; the second is an apparent difference in the angles of incidence and reflection in meridian observations; and the third is an apparent periodic error in connection with occultations of stars by the moon. For the direction of motion the first method gives $\alpha = 4h.\ 35m.$; the second $\alpha = 4h.\ 36m.$, $\delta = +44°$; and the third $\alpha = 3h.$ to $4h.\ 30m.$, and, with $\delta = +45°$, $v = 750$ km. per sec. A. Wh.

1787. *Is the Moon Radio-active?* **M. Brillouin.** (Comptes Rendus, 182. pp. 822–823, March 29, 1926.)—It appears probable that the moon is radio-active, and that the radiations emitted have an appreciable effect upon the ionisation of the upper atmosphere, which might cause regular lunar periodicities in terrestrial magnetic and atmospheric electrical phenomena. A. W. L.

1788. *Orbit of Neptune's Satellite and Pole of Neptune's Equator.* **W. S. Eichelberger** and **A. Newton.** (Roy. Astron. Soc., M.N. 86. pp. 276–294, March, 1926.)—A complete discussion of the orbit of Neptune's satellite was published by Hermann Struve, which included all observations made from the date of discovery in 1846 up to 1892. Newcomb added to this all observations up to 1908, and when, several years after his death, the U.S. Nautical Office received from his family his uncompleted work, it was finished and brought up to 1923. New values have thus been obtained for the position of the pole of Neptune's equator and for his mass, and for the orbit and mean distance of the satellite. Further details will be published in the Astronomical Papers of the American Ephemeris, Vol. X, Part III. M. A. E.

1789. *Figure and Rotation Period of Neptune.* **J. Jackson.** (Roy. Astron. Soc., M.N. 86. pp. 294–296, March, 1926.)—Neptune seen from the Earth presents a disc about 2″·5 in diameter, apparently perfectly circular and without definite markings. Photometric observations by different astronomers have indicated variability in a period of about 7·8 hours; but this implies an oblateness great enough to be visible telescopically, and greater than is probable when compared with the Earth, Jupiter and Saturn. Widely different conclusions are here drawn, based on the position of Neptune's axis of rotation and on the rate of motion of the pole of the satellite's orbit about the pole of Neptune's equator as determined recently [see preceding Abstract]. The difference between Neptune's equatorial and polar diameters cannot be more than 0"·04, and the period of rotation is 19·1 hours. Possibly the period is two or three times that derived from the photometric observations due to darker or brighter areas on the planet's surface at intervals of about 180° or 120°. A period of 19·1 hours indicates an equatorial velocity of only 2·5 km./sec., so it is hardly possible with our present means to determine the rotation by the Doppler-effect. M. A. E.

1790. *Mean Elements and Perturbations by Jupiter of the Minor Planet (483) Seppina.* **A. Jenvall.** (Astron. Iakttagelser och Undersökningar, Stockholm, 11. 2. [43 pp.], 1926. In German.)—This investigation was undertaken, at Bohlin's suggestion, as a test of what degree of accuracy could be obtained by applying his method of calculating planetary perturbations to a certain class of cases; the result is favourable. M. A. E.

1791. *Galileo Memorial Sun Tower at Florence.* **C. du R. Preller.** (Engineering, 121. pp. 550–553, April 30, 1926.)—A fixed vertical tower, like those at Mt. Wilson, was inaugurated in June, 1925, and is worked by A. Abetti. The mechanical equipment is by Italian firms, the optical instruments from the Zeiss works in Jena, and the diffraction reticule (100,000 lines) from the Mt. Wilson Towers optical works. The tower is built of open iron-work and reinforced concrete in braced sections, the dome (13·12 ft. by 10 ft.) is double, its external section being movable with the wind and electrically controlled for rotation; there is a pit for the combined spectrographic and spectroheliographic apparatus. The cœlostat (13·6 in. in diameter and 6 in. thick) is controlled by clockwork gear, together with an electric regulator so as to follow the sun; it reflects a solar beam to the upper mirror, and thence vertically down to the double-lens objective (12 in. in diameter), which transmits the rays through the double-walled ventilated telescope tube (3·28 ft.) to the focal plane (60 ft.) below in the observation and operating chamber at the base, producing a solar image of 7 in. diameter. The whole installation is controlled electrically and operated from the base chamber. The work will include observations of sunspots and prominences, circulation of metallic vapours in sunspots, the determination of the polarity and intensity of the magnetic fields, and the reciprocal relations of solar and terrestrial phenomena. A. S. D. M.

1792. *Diffraction of a Solar Image by a Rectangularly Stopped Lens.* **M. Hamy.** (Comptes Rendus, 182. pp. 993–996, April 26, 1926.)—The author takes the expression giving the angular intrinsic brightness on any point of the solar disc which was derived in an earlier paper [see Abstract 497 (1925)]. This has been shown to be in good accord with observations. The diffraction image produced by a lens stopped down to rectangular form is considered. The paper is mainly mathematical. A. Wh.

LIGHT.

1793. *Centennial of the Undulatory Theory of Light.* **P. S. Epstein.** (Science, 63. pp. 387–393, April 16, 1926. Paper read before the Astron. and Physics Club, Pasadena, California.)—Historical.

1794. *Atoms of Light and of Electricity.* **C. D. Ellis.** (Engineering, 121. pp. 326–327, March 12; 361–362, March 19, and pp. 423–424, April 2, 1926. Nature, 117. pp. 895–897, June 26, 1926. Three lectures read before the Royal Institution.)—The first two lectures reviewed processes which involve the absorption of light, apparently in quanta, while the third dealt with the scattering of light, which was concerned in the phenomena of light reflection, refraction, polarisation and interference. The older textbooks mainly limited their consideration to these phenomena, which the classical undulatory theory explained so well. This theory also accounted for the variation of scattering with the wave-length of incident light and even admitted of determining the number of electrons in an atom. But, in 1922, Compton showed that scattering was accompanied by a change in wave-lengths which was inconsistent with certain experiments he had made, but were consistent with the quantum theory. The third lecture was mainly devoted to this question. All three lectures were copiously illustrated by experiments. G. W. DE T.

1795. *Absorption of Ultra-violet Rays by Aldehydes.* **S. A. Schou.** (Comptes Rendus, 182. pp. 965–967, April 19, 1926.)—Refers to a paper by Bielecki and Henri [see Abstract 1679 (1912)]. The explanation there given that an absorption then observed in the remote ultra-violet was due to groups CH_3 and CH_2 seems inadmissible; if there were such absorption it would probably be due to an enolic group $= C - CH - OH$; but with pure substances this absorption is so small that the enolic group must be less than $\frac{1}{12000}$ of the whole. At $\lambda = 2800$ Å. there is an absorption which partly disappears when the solvent is water; 26 % of acetic aldehyde and 50 % of propionic aldehyde become hydrated. A. D.

1796. *Light Absorption in Coloured Alkali Halides.* **W. Flechsig.** (Zeits. f. Physik, 36. 8. pp. 605–614, 1926.)—Absorption spectra were determined for crystals of NaBr, KCl, RbCl and KBr at room-temperature and at – 180° C. The crystal, in the form of a disc 3–7 mm. thick, was made plane parallel and polished, placed in a carrier surrounded by liquid air, and inserted in a german-silver tube closed at the ends with quartz plates. Part of the crystal was exposed to Röntgen-rays for a short time and consequently coloured. The absorption coefficients of the coloured and natural parts were then measured. The absorption curves had the same general form at – 180° C. as at room-temperature, but at the lower temperature the curve extends over a smaller range of wave-lengths, the degree of absorption is increased, and the maximum is displaced towards shorter wave-lengths. Comparison of the results with the electric measurements of Gudden and Pohl [Abstract 841 (1926)] shows a close similarity between light absorption and electric conductivity. Thus it is better to use the optical method rather than the electrical to examine the crystals, for less energy is used, it is more rapid, and the colouration is rapidly lost. Finally, the most important numerical results for optical absorption are tabulated and used to discuss the question of how far derangement of the crystal lattice and excitation act in the same sense as rise of temperature. R. S. R.

1797. *Refractive Index of Gases and Vapours in a Magnetic Field.* **R. Fraser.** (Phil. Mag. 1. pp. 885–890, April, 1926.)—An attempt to detect a change in refractive index of a gas in a magnetic field due to the orientation of atoms in accordance with the theory of space quantisation developed by Sommerfeld. A Jamin interferometer was used, one tube being evacuated and one filled with the substance under examination and surrounded by a solenoid giving a field of 184 gauss. A shift of the fringes on putting on the magnetic field was looked for. A change in refractive index of ½ % could have been observed, but null results were obtained for H_2, O_2, N_2, CO_2 and sodium-vapour at 475–410°C. The results are discussed carefully. W. H. Ge.

1798. *Glare and Visibility.* **L. L. Holladay.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 271–319, April, 1926.)—Describes a number of different experiments on different aspects of the glare problem. The test used was mainly that of minimum perceptible brightness contrast, several forms of test object being used for the determination of this quantity. The researches included an investigation of the effect of veiling glare and of the influence of adaptation. It is found that the contrast sensitivity S is related to the angular size d of the test object by the equation $S = k(d - 0{\cdot}5)^{0{\cdot}4}$, where d is in minutes and lies between the limits 0·7 and 10. The effect of a dazzle source in the field of view is found to be such that S varies directly as the illumination at the eye from the dazzle source, inversely as the square of the angular separation of source and object, and is practically independent of the brightness, size, type and distance of the source. A theory of dazzle glare based on the scattering effect of the eye media is treated mathematically. Researches on the following subjects are also described: (*a*) after-images, (*b*) irradiation, (*c*) blinding brightness, an attempt being made to correlate the value of a function of brightness and angle with the qualitative evaluation of the sensation evoked. Pupillometric measurements under various conditions are given in a final section of the paper. J. W. T. W.

1799. *Theory of Babinet Compensator.* **J. T. Groosmuller.** (Zeits. Instrumentenk. 46. pp. 198–204, April, 1926.)—Gives a theoretical treatment of the error introduced in a compensator when the optic axes of the wedges are not strictly perpendicular. The practical method used for determining the error in any particular case is described and an example is given. The error can be measured to an accuracy of at least one minute of arc. J. W. T. W.

1800. *Sensitive Nichols Radiometer.* **O. Sandvik.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 355–359, April, 1926.)—Describes in detail a form of Nichols radiometer used in an investigation of infra-red spectra *in vacuo*, in which the sensitivity of the instrument was increased chiefly by reducing the mass of the vanes. The maximum sensitivity is at a pressure of about 0·021 mm. Hg, agreeing with the result of Westphal.

One of the instruments which attained its maximum deflection in 2 mins. gave a deflection of 15,000 mm. per mm.^{2} for a Hefner lamp at a distance of 1 m. W. H. Ge.

1801. *Radiation Potentiometer.* **D. C. Stockbarger.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 349–354, April, 1926.)—Describes the principle of the potentiometer device used in radiometric work by Coblentz and others. The actual design of the instruments will be given in a later paper. W. H. Ge.

1802. *An Improved Infra-red Spectrometer and a Universal Spectrograph.* **C. Leiss.** (Zeits. f. Physik, 36. 1. pp. 60–72, 1926.)—A description of two new instruments. (1) An infra-red spectrometer for measurements up to 15 μ, after a design by C. Schäfer. The dispersion may be doubled, using a second prism; the dispersing system is turned by an endless screw with a graduated head, and a new type of symmetrical slit is provided. (2) A spectrograph for the region $\lambda\lambda$7000–2000 having interchangeable glass and quartz optical parts. Quartz lenses are used in both cases, and the prisms can be interchanged quickly. A. C. M.

1803. *Contribution to the Theory of the Faraday-Effect.* **J. Frenkel.** (Zeits f. Physik, 36. 3. pp. 215–250, 1926.)—The view is held by Dorfmann [Abstract 2513 (1923)] and Ladenburg [Abstract 612 (1926)] that paramagnetic substances should exhibit abnormal magnetic rotation of the plane of polarisation. It is shown in a mathematical thesis, both by classical and by quantum theory, that the total Faraday-effect may be separated into two parts, of which one corresponds to the ordinary diamagnetic effect and the other to the Dorfmann-Ladenburg effect.

G. E. A.

1804. *Apparatus for Locating a Plane of Polarisation in the Ultraviolet.* **G. Bruhat, M. Pauthenier** and **A. Cotton.** (Comptes Rendus, 182. pp. 888–891, April 7, 1926.)—Light is doubly filtered through a monochromator, with three 1-mm. diaphragms, before entering a polarimeter provided with a pair of Glazebrook prisms " cemented " with glycerine. A series of circular images is produced automatically on a plate at equally spaced settings of the analyser, and the blackening is measured with a microphotometer. On plotting the intensity against the reading of the analyser the axis of symmetry of the curve can be located under favourable conditions within 1/10 of a minute. In commenting on this note, Cotton claims that the principle is essentially the same as in the apparatus of Cotton and Descamps [see Abstract 984 (1926)], and that difficulties originally encountered in using it have been overcome by subsequent improvements. T. M. L.

1805. *Rotatory Power in the Ultra-violet of Tartaric Acid in Dilute Solution.* **G. Bruhat** and **M. Pauthenier.** (Comptes Rendus, 182. pp. 1024–1026, April 26, 1926.)—Bruhat (Thesis, Paris, 1914) and de Mallemann [see Abstract 1115 (1923)] have supposed that the rotatory dispersion of tartaric acid would become normal at infinite dilution, whereas Lowry and Austin [see Abstract 2259 (1924)] have supposed that the dispersion would remain complex. By using the apparatus recently described [see preceding Abstract] and enclosing the solution in a polarimeter tube closed by a pair of compensated quartz discs, measurements have been made at concentrations of 1 and 0·25 % and at wave-lengths down to 3130 Å.U. These reveal a reversal of sign at short wave-lengths, proving that the rotatory dispersion is still anomalous; but the authors claim that the changes of rotatory power in dilute solutions are so rapid that the values now recorded could not have been predicted by extrapolation, and that in this range the rotatory power is probably determined by the electrolytic dissociation of the acid. T. M. L.

1806. *Optical Rotation of Camphor.* **R. Lucas.** (Comptes Rendus, 182. pp. 1022–1024, April 26, 1926.)—Measurements have been made on solutions of camphor in C_6H_{12}, H_2SO_4 and H_3PO_4 throughout the visible spectrum, which show that this substance obeys Biot's law of mixtures. Certain of Longchambon's conclusions are discussed. Whilst it is agreed that the two Drude terms proposed by Lowry and Cutter are insufficient on theoretical grounds, it is pointed out that the specific rotatory power cannot be found from one such term for each kind of rotating substance, but that the proportion of the two kinds needs to be known. From classical theory it is to be expected that the rotatory power will tend to zero for very short waves, as does the magnetic rotation, while the refractive index tends to unity. [See also Abstract 1295 (1926).] F. S.

1807. *Coherence and Consonance of Light.* **M. Berek.** (Zeits. f. Physik, 36. 9–10. pp. 675–688, 1926.)—Part I of a research in which it is shown that the principle of undisturbed superposition of vibrations in relation to the coherent and incoherent properties of unpolarised light leads to a finite time of delay; from which follow maximum coherence-lengths, the domain of natural monochromatic light, etc. It is necessary to assume a restriction upon the complete irregularity of the polarisation condition of completely unpolarised light. Parts II, III and IV will deal with interference under great path differences, with interferences associated with refraction, and with the optical formation of non-self-lighting objects. A. D.

1808. *Diffraction by a Grating.* **G. Breit.** (Washington Acad. Sci., J. 16. pp. 201–204, April 19, 1926.)—Shows that the grating and the photographic plate may be looked upon as a complex atom. Duane's hypothesis of the transfer of momenta in quanta in interference leads to the result that in addition to the quantum numbers of the emitting atom one may speak also of a quantum number of the grating, and that diffraction in various directions is given by different changes in that quantum number. A. D.

1809. *Silver Iodide in Photographic Emulsions.* **W. D. Baldsiefen, V. B. Sease** and **F. F. Renwick.** (Phot. J. 66. pp. 163–181; Disc., 181–184, April, 1926.)—The earlier literature of the attempts to utilise gelatine emulsions containing silver iodide for photographic purposes is reviewed and discussed. An experimental study was made of photographic emulsions containing silver iodide in addition to the usual silver bromide. The method of sedimentary analysis was employed for obtaining emulsified silver iodide of reasonable uniformity, and of different grain size. The photographic properties of the emulsions containing different proportions of silver iodide with varying grain size were determined. The size of the grains in the silver iodide emulsions was found to have scarcely any influence on the photographic characteristics of the resulting silver iodo-bromide emulsions. The silver iodide behaves in all cases similarly to potassium iodide, so that its photographic action can only be accounted for by conceding it almost equal facility for uniting by peptisation and by adsorption, with freshly precipitated silver bromide. Silver iodide applied to already existing silver bromide is found to exert a powerful initial desensitising action. F. J. B.

1810. *Characteristics and Anomalies of Emulsions on Development. Part I.* **S. E. Sheppard.** (Eastman Kodak Co. Research Lab. Comm. No. 261. Phot. J. 66. pp. 190–200, April, 1926.)—Instances of the variability of behaviour of photographic emulsions, particularly negative emulsions, are cited, particularly with reference to the studies by W. Clark [see Abstract 1357 (1925)] and O. Bloch, and confirmed by new data. It is pointed out that "anomalous" kinds of emulsion have a lower degree of complete reproducibility, giving an identical family of characteristic curves for different times of development. They are much less amenable to the application of the laws of tone reproduction, to automatic processing, and application in science and technology. The precise factors are considered to be (*a*) the grain-size frequency, which is controlled by precipitation and ripening (in the sense of recrystallisation and grain-growth), and (*b*) the distribution of sensitivity specks, *i.e.* size-frequency distribution of silver-sulphide nuclei. Orthophotic and unorthophotic emulsions are defined in terms of behaviour for different times of development. Orthophotic emulsions give a family of characteristics, the straight-line portions of which give unambiguously a single tie-point. In discussing variations of emulsion type within the orthophotic definition, it is shown that all industrially used emulsions, including portrait emulsions, are producible with this restriction. A. B. C. L.

1811. *Photographic Problems encountered in the Transmission of Pictures by Electricity.* **H. E. Ives.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 173–194, March, 1926.)—This paper deals with some problems of photographic tone reproduction which arise upon the introduction of an electrical transmission system between a picture placed on the sending apparatus in one place and the copy of the picture made by the receiving apparatus in another. Some of these problems arise because of limitations introduced by the use of the electrical transmission line; others arise because of opportunities for the control of picture quality which are not afforded by ordinary photographic methods. The following are the chief points considered: Characteristics of a typical transmission system; methods of picture reception; characteristics of received pictures corresponding to various methods of transmission; variable density pictures; variable-sized structure pictures; practical choice of operating method; special procedures. The paper is illustrated with a series of graphs. A. E. G.

1812. *Relation between Time and Intensity in Photographic Exposure.* **L. A. Jones, E. Huse** and **V. C. Hall.** (Eastman Kodak Co. Research Lab. Comm. No. 253. Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 321–348, April, 1926.)—Work has been continued on the failure of the photographic reciprocity law, $E = It$. The failure of this law, using panchromatic and orthochromatic emulsions, is somewhat greater than reported previously for high-speed, non-colour sensitive emulsions. Slow ordinary and lantern emulsions show very great failure and also a marked change of gamma with intensity. In general, for fast plates the variation of density with intensity is small, optimal intensity is at a low value, and gamma is independent of intensity. For slow plates the density variation is great, optimal intensity high, and gamma drops at low intensities. As found by Kron, optimal intensity shifts to higher values with increasing development of time. Kron's usually accepted empirical law does not fit the observed data. An alternative form

$$It = I_0 t_0/2[(I/I_0)^a + (I/I_0)^{-a}]$$

has been found to fit the observed data for fast plates over a range of 1 : 8,000,000 in intensity and for slow plates at high intensities. For these emulsions the observed failure is greater than the calculated curve indicates at low intensities. This equation was suggested by Kron, but it did not fit his observations. The observed data thus far indicate that the dependence of gamma on intensity follows as a result of changes in the effective grain-size frequency function caused by a differential failure of the reciprocity law for grains of different sizes and sensitivities.

A. E. G.

1813. *Neocyanine : A New Sensitiser for the Infra-red.* **M. L. Dundon, A. L. Schoen** and **R. M. Briggs.** (Eastman Kodak Co. Research Lab. Comm. No. 255. Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 397–400, April, 1926.)—Hitherto dicyanine has been the best sensitiser for infra-red [Abstract 884 (1922)]. Kryptocyanine, though the most powerful sensitiser to date, does not keep. Neocyanine is a dye which was separated by H. T. Clarke in the preparation of kryptocyanine. This new dye is found to have extremely good infra-red sensitiveness, and is supplied either as plates or alone. The mercury line at 10,140 can be photographed in 1/5 time required for dicyanine, and even 11,288 can be obtained with long exposures. Neocyanine sensitises more powerfully beyond 8000 than any other dye. J. E.

o **1814.** *Illumination Photometer with Maxwellian View.* **A. Blondel.** (Rev. d'Optique, 5. pp. 49–54, Feb., 1926.)—Describes the form of portable photometer recently devised by the author. [See Abstract 2480 (1925).] J. W. T. W.

1815. *Spectral Distribution of Sensitivity of Photographic Materials.* **L. A. Jones** and **O. Sandvik.** (Eastman Kodak Co. Research Lab. Comm. No. 256. Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 401–416, April, 1926.)—The purpose of this paper is to describe the apparatus, to outline the method of procedure, and to give the values obtained for the spectral sensitivity of four emulsions in the region from 3000 Å. to 7000 Å. Two monochromatic illuminators in series are used to reduce the percentage of the stray radiation to a minimum. The results of the investigation on spectral distribution of sensitivity show the maximum sensitivity to occur in the ultra-violet. Gamma increases with the wave-length in the spectral region investigated ; and the increase becomes more marked for longer times of development. The maximum gamma is a minimum in the ultra-violet, increasing generally towards the red end of the spectrum; K, on the other hand, varies in the opposite direction. Further work is in progress. A. E. G.

1816. *Brightness of Black Body.* **P. Fleury.** (Ann. de Physique, 5. pp. 265–358, March–April, 1926.)—Describes, in detail, experimental work carried out with the object of developing a "black-body" standard of light. The temperature of the black body is defined by the ratio (N) of its radiation intensity to that of a black body held at the gold point, measured in the wave-length 0·622 μ. This ratio is measured by means of a spectrophotometer and a sector disc, and is regarded as determinable to 1·25 %. The radiation of the black body actually used does not differ by more than 0·6 % from the theoretical value. For a radiator matching in colour an ordinary carbon standard lamp N lies between 450 and 470, and within this range the brightness B in candles per square cm. is given by $B = 68 \cdot 5 + 0 \cdot 14(N - 460)$. The precision is estimated at better than 1·4 %. The work is being carried on to higher temperature enclosures. J. W. T. W.

1817. *Photographic Spectra of Tribo-luminescence.* **D. M. Nelson.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 207–215, March, 1926.)—After a few introductory remarks about tribo-luminescence a list of minerals showing the phenomenon is given. References are also given to artificial preparations. In these experiments spectrograms of tribo-luminescence have been obtained for the first time, using sphalerite, chlorophane and artificial zinc sulphide. The material was fashioned into a grindstone and a brush of carborundum used to produce the tribo-luminescence by friction. The colour of the phosphorescence, fluorescence and tribo-luminescence produced by the same substance appears to be the same. J. E.

1818. *Long Duration "Fluorescence" of Uranyl Salts and their Solutions.* **F. Perrin.** (Comptes Rendus, 182. pp. 929–931, April 12, 1926.)—Following Jean Perrin, the writer distinguishes between fluorescence and phosphorescence quite apart from duration. In the case of "true fluorescence" the mean life of an excited molecule is given by $T = T_0\rho$, where ρ is the luminous emission [see Abstract 1018 (1926)]. It is thought that in the case of solutions of uranyl salts the duration of emission is very short, simply because the output is small. By dissolving uranyl sulphate in pure sulphuric acid a solution is obtained one-fourth or one-fifth as bright as the solid salt. This corresponds to a mean life of 1/2000 sec. The result is taken to confirm the idea that the luminescence of uranyl salts is a *fluorescence of long duration* analogous to the fluorescence of colouring matter. The poisoning effect of many diverse substances on the uranyl salts is taken to be similar to the effect of certain salts (iodates and sulphates) on dyes, and to be due to the formation of more stable groups with the activated molecules. J. E.

1819. *Transition Probabilities and Principal Quantum Numbers.* **F. C. Hoyt.** (Nat. Acad. Sci., Proc. 12. pp. 227–231, April, 1926.)—On first consideration it would appear that a simple means of confirming or correcting an assignment of quantum numbers to the terms of a spectrum is afforded by a comparison of transition probabilities calculated on the basis of the correspondence principle with values obtained experimentally from the intensities of the lines, their dispersion or similar properties. On closer examination, however, the author shows that if the calculation is made on the basis of the ordinary conception of the correspondence principle the transition probabilities in series spectra will be to a first approximation independent of the principal quantum numbers assigned to the terms, in spite of the fact that the order of the corresponding harmonic is determined by the change in these numbers during a transition. This approximate independence follows as a result of the general assumptions as to the nature of the motion of the series electron which have been used for an interpretation of the main features of series spectra. From the standpoint of the quantum theory in the form on which calculations have so far been based, it does not appear that the discussion of transition probabilities affords a practical method for checking the principal quantum numbers. In particular the author is unable to agree with Kuhn's tentative conclusions drawn from his measurements of the magnetic rotation of the plane of polarisation in thallium vapour as to the necessity of modifying Bohr's original assignment of principal quantum numbers in this element. The reasons for the above statements are shown from a consideration of the way in which it is possible to estimate the corresponding amplitudes from which the transition probabilities may be calculated. H. H. Ho.

1820. *Correspondence Principle and the Absolute Intensities of Spectral Lines.* **R. C. Tolman** and **R. M. Badger.** (Nat. Acad. Sci., Proc. 12. pp. 173–174, March, 1926. Phys. Rev. 27. pp. 383–396, April, 1926.)—In the work described in this note the correspondence principle (which postulates a relation between the average rate at which energy is actually being discontinuously emitted by quantum transitions and the continuous rate of emission which would be calculated on the basis of the classical theory) is subjected to a new kind of test based on the prediction of the absolute intensities of spectral lines. The paper concludes: "The results considerably increase our confidence in the correspondence principle, justify us in subjecting it to further tests, and lead us to hope that a precise quantitative formulation of the principle will ultimately be found." A. B. W.

1821. *Electronic Structure and Band-spectrum Structure in Diatomic Molecules.* **R. S. Mulliken.** (Nat. Acad. Sci., Proc. 12. pp. 144–151, March, 1926.)—Part I. Kratzer and Kramers and Pauli have developed a formula for the energy contribution due to molecular rotation or precession:

$$Em = Bm^2 + \dots = B(\sqrt{j^2 - \sigma^2} \pm \epsilon)^2 + \dots$$

In this σ is the component of the vector electronic angular momentum (j_e) perpendicular to the nuclear angular momentum vector m, while ϵ is the component of j_e parallel to m. Consideration of the band-spectra of CN, BO, N_2, CO and NO leads to the formulation of a number of postulates based on the assumption that the electronic configuration of molecules is similar to that of atoms. In most molecules the orbits of the outer electrons are of the ϵ type for S states, and of the σ type for P or D states; multiplicity appears to be determined solely by the valence electrons; and Sommerfeld's j values represent a true resultant electronic angular momentum of the molecule. Part II. (*ibid.*, pp. 151–158.) The postulates and conclusions deduced in the previous paper are here applied in detail to the band-spectra of ZnH, CaH and HgH. F. S.

1822. *Application of the Method of Kurlbaum and Güntherschulze to the Photometry of Spectral Lines.* (*Effect of Slit Width.*) **C. Heinrich.** (Zeits. f. Physik, 36. 9–10. pp. 782–785, 1926.)—This method [see Abstract 745 (1904)] gives for a slit width, b, the apparent black-body temperature, T_b, of the source under test, at the wave-length λ_0. The equation actually satisfied by T_b is $\int E(X)_\lambda \,.\, d\lambda = \beta(b)_{\lambda_0} . E_s(T_b, \lambda_0)$, where $E(X)_\lambda$ is the emission of the source at λ, $E_s(T_b, \lambda_0)$, that of a black body of temperature T_b at λ_0, and $\beta(b)_{\lambda_0}$ is the dispersion factor for a slit of width b. Thus for each value of b a different black-body temperature T_b is obtained. The author defines the true black-body temperature of the spectral line as that corresponding to a slit width for which $E(X)_{\lambda_0} = E_s(T_b, \lambda_0)$. The slit width so required is much below anything attainable in practice. For calculating the true black-body temperature from the first equation above a knowledge of the distribution of intensity in the spectral line is indispensable. Some experimental work by the author verifies the equation quoted. W. S. S.

1823. *Electronic States of the Helium Molecule.* **R. S. Mulliken.** (Nat. Acad. Sci., Proc. 12. pp. 158–162, March, 1926.)—The band-spectrum of helium is discussed on the hypothesis of Birge that the electronic states of the molecule are essentially similar to those of atoms. It appears that the "main" series of bands corresponds to the "doublet" series of the atom, while the "second" series terms correspond to the singlet terms of the atom. It is suggested the molecule in the two cases is formed from atoms in different stages of excitation. F. S.

1824. *Intensity Ratios of the* $(2s - 2p)$ *Combinations of the Neon Spectrum under Different Exciting Conditions.* **H. B. Dorgelo** and **W. de Groot.** (Zeits. f. Physik, 36. 11–12. pp. 897–901, 1926.)—Previous measurements of intensity ratios observed with a column discharge are discussed. The same combinations were measured under different exciting conditions: column, glow-light, electron impact 23·5 volts, resonance light. It was found that the ratio of intensities

$$(2s_x - 2p_k) : (2s_y - 2p_k) : (2s_z - 2p_k) \ldots$$

was equal for each k under all investigated conditions, whereas the ratio

$$(2s_m - 2p_x) : (2s_m - 2p_y) : (2s_m - 2p_z) \ldots$$

was in every case different. The numerical results are given in four tables. [See Abstract 2283 (1925).] E. F.

1825. *Absorption and Resonance Radiation in Excited Helium and the Structure of the* 3889 *Line.* **W. H. McCurdy.** (Nat. Acad. Sci., Proc. 12. pp. 231–233, April, 1926.)—A summary of results shortly to appear in full in the *Philosophical Magazine*, with some discussion as to their significance. It is found possible to reverse completely several lines by an absorbing column 80 cm. in length. These include not only the principal series of the singlet and doublet systems, but also the diffuse subordinate series—singlets and doublets. Small amounts of hydrogen considerably reduce the absorption. The intensity of the 3889 Å. line was greatly increased by excitation from a second helium tube. This line, as studied by a Lummer-Gehrcke plate, has been found to consist of at least two components. The original paper, being already a summary, should be consulted. J. E.

1826. *Second Spark Spectrum of Iron.* **L.** and **E. Bloch.** (Comptes Rendus, 182. pp. 1018–1020, April 26, 1926.)—Below 2300 Å. the pole lines of the iron arc which form one spark spectrum are found in the condensed spark as long lines. In addition, a second spark spectrum appears in this region as short lines which are more intense at the ends than in the centre. It is suggested that this spectrum corresponds to the next stage of ionisation. The spectrum begins about 2250 Å. and is the only one observable below 2000 Å. A number of wave-lengths in each spark spectrum is given. F. S.

1827. *Magnesium Electrodes in Spectrum Analysis.* **E. Dureuil.** (Comptes Rendus, 182. pp. 1020–1022, April 26, 1926.)—The use of magnesium for spark electrodes, when very small quantities of material are to be sparked, is advocated on account of the few lines belonging to magnesium of which none obscure ultimate lines of other elements. The objection to industrial magnesium is the presence of traces of Cu, Fe, Mn, Si, Ca, Na, Al and C, which precludes its use for testing for these elements. Magnesium seems to favour the production of spark spectra in cases where direct sparking yields poor spectra. F. S.

1828. *Enhanced Lines produced by the Interrupted Arc in Sodium and Potassium Vapours.* **F. H. Newman.** (Phil. Mag. 1. pp. 721–726, April, 1926.)—The emission of enhanced lines in spark discharges between metal electrodes is well known, the emission being due to the relatively large fall of potential in the neighbourhood of the electrodes. In working with a sodium-potassium alloy vapour arc lamp it was noticed that after the arc had been burning for some time, and then quenched, it could be restarted immediately by the application of a potential difference between the electrodes without any preliminary heating or making of contact. The light emitted at first differs from that emitted during steady continuous running, the complex enhanced line spectra of the two elements predominating, their flashing up being due to the relatively high potential fall which operates when the arc is started, double ionisation and enhanced spectra being thereby produced. The theoretical details are briefly discussed and the spectra reproduced. W. V. M.

1829. *Arc Spectra of Iodine, Bromine and Chlorine in the Schumann Region.* **L. A. Turner.** (Phys. Rev. 27. pp. 397–406, April, 1926.)—The arc spectra of Cl, Br and I have been investigated in the region between 2050 and 1230 Å.U. Wave-length tables are given. 1396·5 and 1633·6 Å.U. are the wave-lengths of the lines of longest wave-length of Cl and Br respectively, and correspond to the previously known 2062·1 line of I. Doublet differences of 881, 3685, 7600 wave-number units are found between lines of Cl, Br and I spectra respectively, and are thought to be the separations of the two levels of normal doublet *p* states of the atoms. The probable resonance lines are of wave-lengths 1379·6, 1540·8 and 1782·9 Å.U., corresponding to radiating potentials of 8·95, 8·01 and 6·92 volts. No band-spectrum of HCl appeared in the region investigated, although the excitation was probably favourable for its production. AUTHOR.

1830. *Refractivity, Ionisation Potentials and Absorption Spectra.* **R. A. Morton** and **R. W. Riding.** (Phil. Mag. 1. pp. 726–731, April, 1926.)—The Sellmeier dispersion formula may be written $n - 1 = \frac{N'}{\nu_0^2 - \nu^2}$ for gases. Attempts to verify that ν_0 is the head of an absorption band lead to difficulties. The present paper gives preliminary calculations with respect to substances having absorption bands on the long wave side of 1200 Å., the normal region of ν_0. For monatomic gases ν_0 corresponds to 507·2 Å. and 24·33 volts. The observed value for helium is 24·5 volts, using Cuthbertson's data. Other gases show wide discrepancies. The value of ionisation potentials from the values due to Cuthbertson for refractivity have been calculated for nitrogen, hydrogen, oxygen, carbon monoxide, nitric oxide, ammonia, carbon dioxide and hydrogen sulphide, with moderate agreement with observed ionisation potentials. More complex two-term formulæ are, however, required, such formulæ as the Baly-Sellmeier theory provides reproducing very accurately the values for chlorine. W. V. M.

1831. *Absorption Spectra of Condensed Nuclear Hydrocarbons.* **N. S. Capper** and **J. K. Marsh.** (Chem. Soc., J. pp. 724–730, April, 1926.)—Previous descriptions of the absorption spectra of fluorene and phenanthrene are erroneous, since these hydrocarbons contain anthracene, which cannot be removed by fractional crystallisation, owing to the formation of mixed crystals. Satisfactory purification is effected by repeatedly refluxing concentrated solutions in xylene by the heat of a mercury-vapour lamp, when anthracene polymerises to dianthracene. This is readily removed owing to its slight solubility. Pure fluorene, mp. 114–114·5°, gives a spectrum similar to that of *o*-xylene or other simple benzene derivative. Phenanthrene, mp. 98°, thus purified has a spectrum differing from that of anthracene in strength, band position and arrangement. In each case the purified compounds show no fluorescence. The spectra of anthracene, 9-phenylanthracene, 1 : 2-benzanthracene, octahydronaphthalene, naphthalene, benzene, and bisdiphenylene-ethylene, $(C_6H_4)_2C : C(C_6H_4)_2$, are described. The chief feature common to the aromatic hydrocarbons in this series is a sequence of narrow bands between λλ3000–4000, which have a constant frequency difference of about 142 waves/mm. This common frequency difference is ascribed either to CH : CH linkings or to the possession of $CH\vdots$ groups. Chrysogen, a hydrocarbon of unknown constitution, has an anthracene nucleus, since it polymerises similarly to anthracene itself and has the spectrum to be expected on this hypothesis. [See Abstract 1899 (1925).] L. M. C.

1832. *Energies of the X-Levels.* **A. Carrelli.** (N. Cimento, 3. pp. 144–151, March, 1926.)—Experiment confirms the admissibility of a quantistic quantity *n* coinciding with the theoretical value. This depends upon the orbit containing all the electrons which could occupy it. The absence of disturbing action on the part of the other electrons furnishes an additional proof of the symmetrical distribution of all the orbits constituting a given stratum. A. D.

1833. *Energy Measurements with X-Rays.* **H. Kircher** and **W. Schmitz.** (Zeits. f. Physik, 36. 7. pp. 484–495, 1926.)—Different methods are described for the absolute energy measurement of X-rays and the results compared with the "R" values under similar conditions. It is found that the energy required in the formation of a pair of ions is constant in the long wave-length region of the X-ray spectrum (between 0·5 and 1·5 Å.U.). A. B. W.

1834. *Relation between the Intensity of X-Ray Spectral Lines and the Excitation Voltage.* **A. Smekal.** (Zeits. f. Physik, 36. 8. p. 638, 1926.)—Remarks on the discussion of Stumpen on his recent observations [see Abstract 1361 (1926)]. Stumpen found that the L-series suffer a sudden increase in intensity when the K-series begin to be excited. This was foreseen on the Kossel theory of X-ray excitation. The occasion for the work was the possibility of a doubt as to the validity of the exactness of the Bohr frequency condition in the X-ray region. The well-ordered scheme which the Kossel theory with the combination principle gives for X-ray levels indicates its truth, and experiments such as Stumpen has begun will no doubt only confirm it. J. E.

1835. *A Correspondence Principle in the Compton-Effect.* **G. Breit.** (Phys. Rev. 27. pp. 362–372, April, 1926.)—It is well known that the frequency emitted by a hydrogen atom as it falls from one of its quantised states to another may be expressed as a mean value of the frequency of motion of the electron (or overtone thereof) when averaged in the proper manner over orbits intermediate between the initial and final states. In the present paper it is proved that, similarly, the Compton shift is a properly taken mean of the classical Doppler shift. The quantum frequency actually scattered is thus a properly taken average of the frequency which would be scattered on the classical theory, as the electron is accelerated from its state of rest to its final recoil condition. In like manner the amount of light scattered in various directions may be determined if it is assumed that the intensity in the quantum theory equals a proper average of the intensities scattered according to the classical theory. A comparison is made with observed data on the scattering of γ-rays. The characteristic feature of the present paper is that the corresponding classical electron is assumed to have the same direction of motion as the scattered quantum, whereas an actual classical electron would from symmetry recoil straight forward in the direction of the incident beam, as in Compton's and Woo's theories of intensities. This new point of view eliminates the difficulty of a constant correction-factor which has been encountered by Compton and Woo in their explanation of intensity relations. AUTHOR.

1836. *Separation of the Modified and Unmodified Scattering Coefficients of X-Rays.* **G. E. M. Jauncey** and **O. K. DeFoe.** (Phil. Mag. 1. pp. 711–721, April, 1926.)—The Compton-effect necessitates a new experimental procedure when the scattering coefficient of X-rays in matter is measured, it being necessary to recognise two scattering coefficients, σ_1 for the unmodified and σ_2 for modified intensities ($\sigma = \sigma_1 + \sigma_2$). After a theoretical treatment of previous ideas, two experimental methods of obtaining the scattering coefficient σ (the linear coefficient per unit of solid angle in the direction ϕ with the forward direction of the primary rays) are described. In both methods a known thickness of absorbing material is transferred from a position where the primary X-rays pass through the material to a position where the scattered rays in a certain direction pass through the material before entering the ionisation chamber. The first position is called P and the second Q. Two formulæ are deduced for the ratio σ_1/σ_2 and the experimental procedure described. Thus rays from the source traverse two slits placed side by side and of variable width. Two beams thus defined pass through the same thickness of aluminium at P_1 and P_2 respectively, and thence to the scattering substance. To make observations in a given direction of scattering, a balance method is employed, two ionisation chambers being so arranged that the two beams produce no resultant deflection. Between the scatterer and chambers aluminium absorbers are placed (at say Q_1 and Q_2). The widths of the slits are arranged so as to give no deflection. A certain thickness of aluminium is now transferred from P_1 to Q_1, no corresponding transfer from P_2 to Q_2 being made. Since the modified radiation is more easily absorbed, the balance is upset and one slit readjusted so as to bring the two beams back to equality. From the observations of the slit dimensions now available the ratio σ_1/σ_2 may be found. The quantities themselves may be found absolutely by Crowther's method. Experimental results and details are reserved for a further communication.

W. V. M.

1837. *Reflection by a Crystal of its Own Characteristic Radiation.* **W. Duane.** (Nat. Acad. Sci., Proc. 12. pp. 140–143, March, 1926.)—A molybdenum spectrum reflected from a crystal of KBr shows, beside the normal discontinuities, irregularities at points corresponding to the wave-length of the bromine K-series, interpreted as indicating the reflection by a crystal of its own characteristic radiation. The author maintains that the effect, though small, is a real one, and has often seen similar excess "reflection" of characteristic radiation. The effect is, however, dependent for its appreciable appearance on imperfections of the crystal causing more intense characteristic reflection. W. V. M.

1838. *Note on the "Selective Reflection" of X-Rays by Crystals of Potassium Bromide.* **S. K. Allison.** (Nat. Acad. Sci., Proc. 12. pp. 143–144, March, 1926.)—Allison and Duane obtained evidence that selective reflection of BrKα in KBr took place. Recent work has, however, shown that with perfect crystals no such effect is apparent, Weber and Kulenkampff failing to detect the phenomenon. The author now declares that the results published in conjunction with Duane [see Abstract 2745 (1924)] are regarded by him as unreliable in the respect in question, no higher orders of Kα for Br being indubitably present. The author thus considers that no evidence of reflection of characteristic radiation from KBr of any magnitude previously published is reliable. [See preceding Abstract.] W. V. M.

1839. *A New Multiple X-Ray Spectrograph combining the Powder Diffraction and Monochromatic Pinhole Methods.* **G. L. Clark, E. W. Brugmann** and **R. H. Aborn.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 379–385, April, 1926.)—A description of an outfit designed primarily for the routine study of commercial samples of metals, etc. [See also Abstract 401 (1926).] The Laue diagrams give the orientation

of the micro-crystals, and can be used to show the development of fibre axes in metals and in organic substances. The slit and powder method with a hemi-cylindrical camera gives accurate spacing measurements.
J. E.

1840. *An Effect of Temperature on X-Ray Absorption.* **H. S. Read.** (Phys. Rev. 27. pp. 373–380, April, 1926.)—The variation with temperature of the absorption by sheets of Al, Cu, Fe, Ni, Ag and Pb of the total X-radiation from a tungsten X-ray tube operated at 50 kv. has been studied. The measurements were made by balancing the ionisation currents produced by two X-ray beams from the same tube, one of which passed through the absorber. After proper corrections are made for changes in the density of the absorber and of the air in the path of the beam, there remains a residual effect indicating a true variation of the atomic absorption coefficient with temperature. The results indicate that for all absorbers used the average atomic absorption coefficients for the total X-radiation from the tungsten target increased nearly linearly with the temperature by about 0·2 % per 100° C. up to temperatures near the melting-point of the absorber. The work is being continued to determine the magnitude of the effect at different wave-lengths.
AUTHOR.

1841. *Fine Structure of X-Ray Absorption Edge in the K-Series of Argon.* **D. Coster** and **J. H. van der Tuuk.** (Nature, 117. pp. 586–587, April 24, 1926.)—Certain peculiarities in the fine structure of the X-ray absorption edge (one or two faint bands lying near the main absorption edge) have been noted by various observers, *e.g.* Miss Chamberlain [see Abstract 750 (1926)] ascribes part of this fine structure to chemical changes in the absorbing screen due to prolonged exposure to X-rays when making a photographic record of the spectrum. In order to overcome this difficulty the authors have used argon in the Siegbahn vacuum spectrograph. No fine structure at all was detected, the edge itself being very sharp and prominent. Using the same analysing crystal (gypsum) for the elements chlorine and potassium as absorbers, however, in the same time of exposure (1 to 6 hours), a very good fine structure was easily obtained. Further experiments with a calcite crystal and a very narrow slit (0·025 mm.) revealed two different absorption edges for argon in accordance with the authors' theoretical deductions. A. B. W.

RADIO-ACTIVITY.

1842. *Anomalous Scattering of α-Particles.* **P. Debye** and **W. Hardmeier.** (Phys. Zeits. 27. pp. 196–199, April 1, 1926.)—A discussion of the work of Bieler, Rutherford and Chadwick [Abstract 1832 (1924)] on the scattering of α-particles by thin foils of the light elements Al and Mg. The anomalous effects observed when the α-particle penetrates close to the nucleus of these elements is considered mathematically. The authors calculate that the aluminium nucleus presents, in effect, a disc of diameter $0{\cdot}76 \times 10^{-12}$ cm. to the oncoming α-particle. A. B. W.

1843. *The Natural Beta-Ray Spectrum of RaD.* **L. F. Curtiss.** (Phys. Rev. 27. pp. 257–265, March, 1926.)—The natural β-ray spectrum of RaD has been photographed and the energies of its lines directly compared with those of the RaB β-ray spectrum in the same region. The

RaB line Hρ = 660·9, as measured by Ellis and Skinner [see Abstract 1206 (1924)], has been taken as a standard reference line. The following values for the energies of the lines have been determined :—

No.	Intensity.	Hρ.	Energy (volts × 10^{-5}).
1	50	594·3	0·3033
2	3	600·3	0·3092
3	25	709·1	0·4268
4	10	735·2	0·4576
5	1	742·5	0·4663

No. 5 is a line which has previously escaped detection. The analysis of this spectrum for determining the energy of the γ-ray responsible for it shows conclusively that the γ-ray is emitted *after* the disintegration. This is in accord with Meitner's view [see Abstract 697 (1923)]. The energy of the γ-ray is determined as 0·467 × 10^5 volts. AUTHOR.

1844. *β-Rays produced by Collision* (*δ-Rays*). **P. Auger.** (J. de Physique et le Radium, 7. pp. 65–68, March, 1926.)—Many of the electrons set free when α-particles traverse a gas possess sufficient kinetic energy to produce ionisation in their turn also. Wilson's condensation method reveals the ionised tracks of such low-velocity electrons. The present investigation deals with the passage of α-particles from polonium and ThC′ through an atmosphere of hydrogen. By means of auxiliary electric fields it is shown that the collisions between α-particles and electrons are in accordance with the classical laws of dynamics, this having been verified as regards direction, velocity and number of electrons projected. Photographs showing tracks of α-particles and δ-rays (β-rays by collision) are reproduced in illustration. A. B. W.

1845. *The Efficiency of β-Ray Recoil of Radium C from Radium B.* **A. W. Barton.** (Phil. Mag. 1. pp. 835–845, April, 1926.)—Describes the apparatus used in a determination of the " efficiency " of the recoil of RaC atoms produced from RaB when disintegration by emission of a β-particle takes place. Radium active deposit was obtained on a platinum wire and left for 30 mins., so that the RaA decayed away. The wire was then introduced into a glass chamber, which was exhausted to about 10^{-4} mm. of Hg, the wire being then heated to about 400° C. by an electric current passed through it. A cold brass plate, 4 mm. in diameter and highly polished, was placed just above the heated wire, and the RaB and RaC distilled over on to it. The current was then cut off, the brass disc was turned through 180°, so that the face on which the RaB and RaC had condensed was on the top, and a receiver was lowered by a windlass until its lower horizontal surface was very near the surface of the brass disc. Recoil atoms of RaC from the RaB on the disc passed to the receiver, and this recoil was allowed to proceed for 30 mins., when air was admitted to the apparatus and receiver and cold disc removed. Their activities were then measured by means of a suitable electroscope, and it was found from the decay curve that, with suitable precautions, nearly pure RaC was obtained on the receiver. The maximum value of the efficiency of recoil was 6 %. A suggestion is made to account for the fact that the proportion between the number of RaC atoms thus collected and the number formed in the time of experiment whose direction of recoil is vertically upward is so small. H. N. A.

1846. *Compton-Effect with γ-Rays.* **G. Hoffmann.** (Zeits. f. Physik, 36. 4. pp. 251–258, 1926.)—Measurements of the secondary radiation produced in carbon by the γ-rays from a strong radium preparation give the relation between wave-length (derived from the absorption coefficients) and the direction of the radiation. The results are in good agreement with the theory of A. H. Compton [Abstract 1446 (1921)]. A. B. W.

1847. *Distribution of Radio-active Substances in Deep Shafts.* **J. B. Ostermeier.** (Zeits. techn. Physik, 7. 4. pp. 196–198, 1926.)—Describes various methods of determining quantitatively the decay products of radium emanation in the atmosphere and in samples of gas from deep borings. A. B. W.

1848. *Radiation and the Disintegration and Aggregation of Atoms.* **G. E. M. Jauncey** and **A. L. Hughes.** (Nat. Acad. Sci., Proc. 12. pp. 169–173, March, 1926.)—The paper deals with Millikan's discovery of very short wave-length radiation, and criticises Jean's suggestion that radiation of wave-length $1\cdot3 \times 10^{-5}$ Å. is produced when an electron and a proton are annihilated on collision. Various cases of collision between electrons and protons are dealt with in the paper. It is shown also that A. H. Compton's estimated wave-length of $\lambda = 0\cdot0004$ Å.U. for the Millikan radiation is probably incorrect, a value 0·0024 to 0·0032 Å.U. being obtained when Jauncey's theory is applied. A. B. W.

1849. *Radio-active Luminous Compounds.* **K. W. F. Kohlrausch.** (Elek. u. Maschinenbau, (Lichttechnik), 44. pp. 37–43, April 25, 1926.)—A general description of the properties of radium paints and the course of the brightness curve during life. Methods of photometry suitable for this work are described. The paper is for the most part an abridgment of G. Berndt's "Radioaktive Leuchtfarben." J. W. T. W.

1850. *Direction at Sea-level of Cosmic Radiation.* **L. Myssowsky** and **L. Tuwim.** (Zeits. f. Physik, 36. 8. pp. 615–622, 1926.)—The author reviews the results already obtained by Gockel, Kolhörster, Swann and Millikan on this type of radiation [see Abstracts 1693 (1915), 1098 (1924) and 935 (1926)]. Experiments were conducted in Leningrad at the top of a water tower employing a Kolhörster electroscope and observing through a microscope. Observations could be made with the water tank empty or filled to various depths with water, and through this the radiation measured had to pass. It was found that the whole of the hard radiation comes from celestial space, and from measurements in various directions no change with azimuth could be detected. A curve was obtained for the variation of intensity with angle of incidence, and from this a further curve deduced for the intensity of radiation in free space in terms of the height of the homogeneous atmosphere and the absorption coefficient of this radiation in air at 0° C. and atmospheric pressure. This gives absorption coefficients for air of $(2\frac{1}{2} \pm \frac{1}{2})\ 10^{-6}$ cm.$^{-1}$ and for water of $(2\frac{1}{4} \pm \frac{1}{4})10^{-3}$ cm.$^{-1}$. Making a reasonable allowance for absorption, the value for water agrees well with that found by the authors from their Lake Onega experiments [Abstract 934 (1926)]. It also agrees well with results found by other experimenters. Since there is no evidence of any remarkable deviation of this radiation in the earth's magnetic field it is considered to be a hard ether radiation. R. S. R.

HEAT.

1851. *Thermal Conductivity and Thermal E.M.F. of Single Crystals of Several Non-cubic Metals.* **P. W. Bridgman.** (Am. Acad., Proc. 61. 4. pp. 101–134, Feb., 1926.)—Unicrystalline castings of the metals were made by methods previously described [see Abstract 318 (1926)] of dimensions about 10 cm. long and 6 mm. in diameter. The thermal conductivity was measured at room-temperature, and the thermal e.m.f. between room-temperature and 100° C. For zinc, cadmium and tin fairly complete results are given in all possible orientations in the crystal and for bismuth over a restricted range of orientations, whereas for antimony and tellurium only measurements of thermal e.m.f. have been made, owing to the mechanical difficulty of obtaining suitable specimens. The results obtained are used for testing the relation of Voigt, that $\lambda_\theta = \lambda_\perp + (\lambda_{11} - \lambda_\perp) \cos^2 \theta$, where λ_θ denotes the thermal resistance in the direction inclined at angle θ to the axis, $\lambda_\perp$ and λ_{11} the resistances perpendicular and parallel to the axis of rotational symmetry. Combining this with similar relations for electrical resistance ρ_θ, it is shown that λ_θ is a linear function of ρ_θ in virtue merely of the symmetry relations. It is found that Voigt's symmetry relations are satisfied for thermal conductivity. The generalised Wiedmann-Franz law, however, does not hold for all directions in a crystal in that the ratio of thermal to electrical conductivity is in general a function of the orientation. As regards the thermal e.m.f. of the metals against copper, Voigt's symmetry relations are satisfied by the Thomson heat, but in the case of the Peltier heat, which apparently was not considered in Voigt's analysis, the experiments show that the symmetry relations to which it is subject are not the same as those for the Thomson heat. All the results are shown graphically. T. B.

1852. *Thermal Conductivity of Air and Hydrogen.* **E. Schneider.** (Ann. d. Physik, 79. 3. pp. 177–203, March 8, 1926.)—This paper contains a full account of an investigation by the method of Schleiermacher and Weber, carried out by the author with the object of testing if a change of diameter of the wire affected the value of the conductivity of the gas. The principle of the method is that a wire with a large temperature coefficient of electrical resistance is stretched in the axis of a glass tube. The gas to be measured is placed in the tube, and the latter is surrounded by a constant temperature bath. When the stationary state has been reached the resistance of the wire and the current in it are measured. All corrections are carefully investigated and discussed. The change in diameter of the wire was found to have no effect in the case of hydrogen, but with air it produced about 1 % change. Weber's results for hydrogen were confirmed, but for air the author's values for conductivity and temperature coefficient are about 4 % greater than those of Weber.

T. B.

1853. *The Influence of External Heat Losses in the Comparison of Conductivities by Despretz's Method.* **M. Jakob** and **S. Erk.** (Zeits. f. Physik, 35. 8–9. pp. 670–682, 1926.)—The authors have critically examined Despretz's method for the determination of thermal conductivity λ. In the case of two bars coated with the same material, the equation $\frac{d^2t}{dx^2} - \frac{\alpha u}{\lambda f}, t = 0$ holds, where α = external loss of heat. If $\frac{\alpha}{\lambda}$ is independent of x and t, the integral is

$$t = \mathrm{A} \,.\, e^{-\sqrt{\frac{\alpha u}{\lambda f}}x} + \mathrm{B} \,.\, e^{-\sqrt{\frac{\alpha u}{fi}}x} \quad . \quad . \quad . \quad . \quad (1)$$

If t_1, t_2, t_3 are the temperatures at points x_1, x_2, x_3, and $2n = \frac{t_1 + t_3}{t_2}$, then

$$\frac{\log(n + \sqrt{n^2 - 1})}{\log(n + \sqrt{r^{12} - 1})} = \frac{\sqrt{\frac{\alpha u}{\lambda f}}}{\sqrt{\frac{\alpha' u'}{x' f'}}} = \frac{u}{m'}.$$

And if the rods have the same form $\frac{u}{f} \cdot \frac{u'}{f'}$,

$$\frac{\lambda'}{\lambda} = \frac{\alpha'}{\alpha}\left[\frac{\log(n + \sqrt{n^2 - 1})}{\log(n' + \sqrt{n^2 - 1})}\right]^2 \quad . \quad . \quad . \quad . \quad (2)$$

From the investigations of Nusselt it is possible to see how far the assumption that $\alpha = \alpha'$ is justified. Nusselt has shown that α depends on the temperatures of the bars, and its value can be calculated and inserted in equation (1). The integration constants A and B can then be found. Without altering the flow of heat or the temperature distribution another bar of length l can be assumed to be joined to the first with its farthest end kept at temperature t_0, so that the second constant is obtained from $t = t_0$ when $x = 2l$. By a process of successive approximation the true value of α and the mean temperature of the bar can be calculated, and the value of λ thus found compared with that obtained from (2) on the assumption that $\alpha = \alpha'$. This calculation shows that the error increases rapidly as the conductivity of the bar gets less. Since α has been shown by Nusselt to depend on the difference of temperature between the bar and the surrounding air, it must get smaller along the bar from the hot to the cold end. In this case, however, the differential equation cannot be integrated, but the difference equation can be employed:

$$\frac{\Delta^2 t}{(\Delta x)^2} = \frac{\alpha u}{\lambda f} \cdot t = m^2 t \quad . \quad . \quad . \quad . \quad (3)$$

The values of α and the error in λ are calculated and compared with those previously obtained. The influence of radiation is briefly considered by taking the α of equation (2) as made up of two parts, α_1 and α_2, one denoting the conductivity loss and the other the radiation loss. Having considered the influence of the different heat losses on the temperature distribution along the bar for a given value of λ, the author shows how to solve (3) for λ. This gives an absolute value for λ instead of only a comparison. A critical discussion of the exactness of the method follows, together with the best conditions for carrying out the measurements. The well-known measurements of Wiedemann and Franz and also those of Kohlrausch on steels are in error, due to not taking into account the proper value for α. If the dependence of α on the temperature difference between the bar and the surrounding air is taken into account an accuracy of 1 % can be obtained in the value of λ when a comparison is made between two bars whose conductivities are not very different. T. B.

1854. *Dilatometric Investigation of A_3 and A_4 Transformations in Pure Iron.* **S. Satô.** (Phil. Mag. 1. pp. 996–1007, May, 1926.)—A differential method is described for observing dilatation to as high a temperature as 1400° C. It is found that the A_4 transformation is accompanied by an expansion and the A_3 by a contraction, these changes being reversed during cooling. The ratio of changes of length due to the A_3 and A_4 transformations is about 10 : 3, and the thermal dilatation curve of δ-iron forms the continuation of that of α-iron, showing that δ-iron is the same as α-iron, as found by Westgren by X-ray analysis. [See Abstract 2342 (1922).] F. S.

1855. *Ratios of Specific Heats of Nitrogen at Atmospheric Pressure and at Temperatures between* 10° *C. and* − 183° *C.* **J. H. Brinkworth.** (Roy. Soc., Proc. 111. pp. 124–133, May 1, 1926.)—In a previous paper [see Abstract 1686 (1925)] the author has described the method of determining the ratio of specific heats of hydrogen and air. The present investigation employs the same methods and apparatus in a determination of the ratio of the specific heats of nitrogen at temperatures between 10° C. and − 183° C. The final values of γ, the ratio of specific heats of nitrogen, are given in the following table :—

Temperature, °C.	Final Values of γ.	Values obtained by other Observers.
+ 10°	1·4054	1·4045 (20° C.) (1) 1·406 (0° C.) (2)
− 78°	1·4103	—
− 183°	1·4454	1·447 (− 190° C.) (3)

(1) Partington and Howe [see Abstract 1221 (1924)]. (2) Dixon, Campbell and Parker [see Abstract 605 (1922). (3) Valentiner, Ann. d. Physik, 15. p. 74, 1913. A. B. W.

1856. *Specific Heat in Boric Anhydride and in Glycerine.* **M. O. Samsoen** and **P. M. Monval.** (Comptes Rendus, 182, pp. 967–969, April 19, 1926.)—Follows up an earlier investigation [see Abstract 1384 (1926)]. Similar discontinuities found on studying the specific heats as deduced by heating to various temperatures. A. D.

1857. *Incandescence of Lead Wire.* **D. Damianos.** (Phys. Zeits. 27. pp. 289–290, May 1, 1926.)—Describes experiments in the first of which a short lead wire was heated inside a steel tube side by side with a platinum wire. Both wires being viewed through an opening in the tube became incandescent at the same temperature, that is, at over 500° C., the melting-point of lead being 327° C. This depends on an oxide layer on the outside of the wire. When the experiment is repeated in an atmosphere of nitrogen the wire melts into drops long before the platinum wire begins to glow. In the second experiment the resistance of the wire was measured during heating, and a sudden rise in this at a certain point indicated the change from the solid to the liquid state. Since the oxide layer is very thin, it is necessary to assume a certain amount of tensile strength in the liquid " wire " which prevents it from breaking under its own weight. H. N. A.

1858. *Determination of the Temperature of an Acetylene Flame.* **C. Heinrich.** (Phys. Zeits. 27. pp. 287–288, May 1, 1926.)—The method used was that of spectropyrometry, due to Kurlbaum and Güntherschulze, and the temperature estimated from Wien's law. After giving experimental details it is shown that the value of the temperature is 2210° absolute within the limits + 7 % and − 3 %. Ladenburg's value was 2115° absolute, and Féry 2548° absolute, and it is shown that the new value is more correct. S. G. B.

1859. *Diffusion of Salt Vapours in the Bunsen Flame.* **F. J. Symon.** (Roy. Soc. Edinburgh, Proc. 46. 1. pp. 15–19, 1925–1926.)—A bead of the salt under examination was held in the flame. Above it were placed two movable platinum electrodes in circuit with a galvanometer and a battery. To obtain the coefficient of diffusion two points had to be found when the concentration of the vapour was the same. This was done by finding the distance apart of the two points, one on each side of the flame axis, which gave the same current at a height of 1 cm. above the bead, and also for 3 cm. above the bead. The results are then worked out on the basis of a method given by H. A. Wilson [see Abstract 1563 (1912)]. The values obtained for potassium and sodium phosphates (5·8 and 13) agree fairly well with those originally given by Wilson. A. A. D.

1860. *Vapour-pressure and Heat of Dilution of Aqueous Solutions.* **E. P. Perman** and **T. Lovett.** (Faraday Soc., Trans. 22. pp. 1–19; Disc., 19, Jan., 1926.)—The vapour-pressures and densities of concentrated solutions of urea are measured at temperatures ranging from 40° to 80° C. The relation $\log \frac{\pi_0}{\pi} = \frac{n}{N}$, where π_0 and π are the vapour-pressures of solvent and solution respectively and n and N the number of molecules of solute and solvent, is followed closely at all concentrations and temperatures. A still closer agreement is given by the formula $\log \frac{\pi_0}{\pi} = \frac{n}{N + 0 \cdot 1n}$. It is shown that v. Babo's law, according to which the lowering of the vapour-pressure relative to that of the solvent is independent of the temperature, does not hold with these solutions. The heats of dilution are measured by admitting water to urea solutions contained in a special Dewar flask. Heating coils of resistance wire wound on mica strips are inserted, and by passing a known current the temperature is raised so as to compensate for the heat loss on dilution. A stirrer and thermometer are also included. The heats of dilution calculated from the vapour-pressures by Kirchhoff's equation $H = RT^2 \frac{\delta}{\delta T}\left(ln \frac{\pi_0}{\pi_c}\right)$ are compared with those directly observed, and a fair agreement is shown. [See Abstract 291 (1913).] J. N. P.

1861. *Vapour-pressure of Chlorine Dioxide.* **F. E. King** and **J. R. Partington.** (Chem. Soc., J. pp. 925–929, April, 1926.)—A series of measurements of the vapour-pressure of chlorine dioxide were made. The chlorine dioxide was prepared by the action of chlorine on silver chlorate. Pure dry chlorine was passed over silver chlorate, which was kept at a temperature of 85°–95° C., and the chlorine dioxide condensed in a strongly cooled bulb as a crystalline solid of the colour of potassium dichromate. Owing to the vapour-pressure of chlorine dioxide being negligible at − 80° C., it was possible to remove any excess of chlorine. The temperature of the chlorine dioxide was gradually raised and the pressure noted. From the results obtained the latent heat of evaporation of chlorine dioxide can be calculated by the formula :—

$$\lambda = 4 \cdot 567\{\log P_2/P_1\}T_1T_2/(T_2 - T_1) \text{ cal. per mol.}$$

There is no evidence of association in the liquid or the gaseous state, and the formula ClO_2 represents the compound in both states. F. J. B.

1862. *Vapour-pressure of Ozone at Very Low Temperatures.* **A. L. Spangenberg.** (Zeits. phys. Chem. 119. pp. 419–438, April 10, 1926.) —The vapour-pressure of ozone was determined between the temperatures − 193 and − 183 C. by a static method and by a method of transport. Both methods gave results which agreed. The results of the determinations and those obtained at higher temperatures by Beja can be exactly calculated by the Nernst formula :

$$\log P = -\lambda_0/4 \cdot 571T + 1 \cdot 75 \log T - \epsilon \, . \, T/4 \cdot 571 + C.$$

If the pressure is measured in mm., then the constants have the values : $\lambda_0 = 3700$, $\epsilon = 0 \cdot 05099$, $C = 5 \cdot 850$. When the pressure is measured in atmospheres the constant C becomes $C'' = 2 \cdot 969$, and must be substituted in the equation. The boiling-point, calculated from the vapour-pressure formula, is found to be − 112·3, which agrees with the value found by Riesenfeld and Schwab, 112·3. The latent heat of vaporisation and its dependence on the temperature was calculated at absolute zero ; the value was 3700 calories per molecule, and at the boiling-point 2955 cal./mol. The chemical constant of ozone was found to be 2·97, which is only slightly different from that of oxygen, 2·8. F. J. B.

1863. *Condensation of Water from the Air upon Hygroscopic Crystals.* **J. S. Owens.** (Roy. Soc., Proc. 110. pp. 738–752, April 1, 1926.)—The conditions of deliquescence of crystalline salts are studied, in order to facilitate the identification of crystals too small for micro-chemical or crystallographic analysis. Minute crystals are exposed to the air, and their behaviour is observed under the microscope, temperature and humidity being measured at the same time. Tests have been made with pure salts likely to be found in the air, mixtures, sea salt, and the crystals found in dust records. Crystalline dust records, obtained from differing localities, show that the crystals of different salts tend to remain separate on these records, and that the error from impurity may not be very great if isolated crystals are examined. The conditions under which a dry crystalline haze will change to fog, with a very slight increase of humidity, are discussed. A further method of examination is being tested in which the crystals are exposed in a small air-tight cell to the vapour of a pure salt ; under these conditions the crystal deliquesces or remains dry according to whether the vapour-pressure is higher or lower than its own saturated solution. A. W. L.

1864. *Effect of Infra-red Radiation upon the Combustion of Gaseous Mixtures containing Nitrogen.* **W. T. David, S. G. Richardson** and **W. Davies.** (Leeds Philosoph. and Lit. Soc., Proc. 1. pp. 37–39, Oct., 1925.)—Reference is made to experiments described in a previous paper [see Abstract 2548 (1925)]. From the results of these experiments it is concluded that infra-red radiation tends to accelerate the combustion of inflammable gaseous mixtures provided that the radiation is of the kind which is absorbed by the combustible gas, and that nitrogen is present as a constituent of the inflammable mixture. It is suggested that during combustion in a closed vessel there is some kind of temporary association between the nitrogen molecules (or possibly the molecules of the oxides of nitrogen) and those of the combustible gas which tends to retard combustion, and that such association is, to some extent, inhibited when the molecules of the combustible gas acquire vibratory energy by the absorption of infra-red radiation, with a consequent increase in the rate of combustion. **A. B. C. L.**

1865. *Thermodynamic Derivation of a Black-body Radiation Isotherm.* **B. Bruzs.** (Nat. Acad. Sci., Proc. 12. pp. 233–238, April, 1926.)—It is attempted to show that Wien's Displacement Law and an additional assumption are sufficient to define the equilibrium state of a system. This system will obey the Stefan Boltzmann Law. The additional assumption is the thermodynamic explanation of the constancy of Planck's constant *h*. Mainly mathematical. **J. E.**

1866. *On the Experiment of Désormes and Clement.* **E. Foà.** (N. Cimento, 3. pp. 101–113, March, 1926.)—In working out the theory of this experiment it is generally assumed that in each form in which it can be made (*i.e.* with an initial pressure of the air in the receiver greater or less than that of the outer air) the transformation is isoentropic. Even a qualitative analysis shows that with a smaller internal pressure the compression of the air in the receiver cannot be strictly isoentropic even if, as is usually assumed, there be no thermal exchanges between the contained air and the walls of the receiver when the stop-cock is opened. The air initially contained would be isoentropically compressed if it were separated from the inflowing air by a mobile diaphragm impermeable to heat. But under the conditions of the experiment there is a mixing of the inner and outer air, with dissipation of kinetic efflux energy. The phenomenon is not reversible, and therefore not isoentropic. The object of the paper, which is entirely mathematical, is to expound an improved method of finding the expression of *k*. **E. F.**

1867. *Quantisation of the Ideal Monatomic Gas.* **E. Fermi.** (Zeits. f. Physik, 36. 11–12. pp. 902–912, 1926.)—If the Nernst thermal theorem is to hold good for the ideal gas we must assume that the laws of ideal gases at low temperatures deviate from the classical laws. The reason of this deviation is to be sought in the quantisation of the molecular motions. All the theories involve more or less arbitrary assumptions concerning the statistic behaviour of the molecules or their quantisation. The present paper utilises the hypothesis, first advanced by Pauli and based on numerous spectroscopic facts, that one system can never contain two elements of equal value whose quantum numbers are in absolute agreement. The equation of state and the internal energy of the ideal gas are deduced from this hypothesis. The entropy value for high temperatures agrees with that of Stern-Tetrode. Mainly mathematical. [See Abstract 1609 (1926).] **E. F.**

1868. *Evidence of Molecular Changes in Vapours and Gases.* **G. N. Antonoff.** (Phil. Mag. 1. pp. 1121–1145, May, 1926.)—Discontinuities in curves representing variations of some physical properties of liquids with temperature were noted in a previous paper [see Abstract 2126 (1925)], and further evidence is given. These are hardly noticeable in a graph, but it is impossible to represent a long range by a single formula, although two or three separate formulæ can be found for partial ranges, to a higher order of accuracy. The inference is that there are molecular changes at the points of discontinuity. It is also shown that the properties of liquid-liquid systems and liquid-gas systems are governed by identical laws. Thus the meniscus becomes flat as a system of two liquids approaches the point of complete miscibility in the same way as it does at the critical point in a liquid-saturated vapour system. In plotting concentrations against temperature for a liquid-liquid system, discontinuities are very evident. It appears that both temperature and concentration changes favour the formation of complex molecules. Properties depending upon the number of moelcules per unit volume (Raoult's law, etc.) indicate that the number of molecules per unit volume remains the same with increase of concentration in the critical regions, and that the formation of complex molecules is a necessary condition for separation into two phases. The association factor was calculated for ethyl acetate, and varied from 2 at the critical temperature to 864 at 50° C. W. G. B.

1869. *Rotation Entropy of Di- and Poly-atomic Gases.* **K. Széll.** (Zeits. f. Physik, 36. 4. pp. 292–299, 1926. Paper read before the Kgl. Ung. Akad. d. Wiss., Oct., 1925.)—The rotation entropy of the di- and poly-atomic gases is calculated on the basis of Planck's investigations on the physical structure of the phase space, on the assumption that the phase points in the phase spaces of the separate molecules relating to the rotation coordinates may lie only at definite places. The equations obtained for higher temperatures agree with the results found by Sackur, Planck, Tetrode, and Ehrenfest and Trkal. T. H. P.

1870. *Theory of the State of Matter. IV. Molecular Weight and Critical Data.* **F. Schuster.** (Zeits. Elektrochem. 32. pp. 155–157, March, 1926.)—Van Laar (Die Zustandsgleichung, 1924) has shown that for ordinary substances the relation between the van der Waals magnitude a at any temperature and the same magnitude at the critical temperature is expressed by the formula, $\frac{a}{a_k} = 1 + \sqrt{1 - m} - \frac{1}{2}(1 - m)$, where $m = \frac{T}{T_k}$. Further, $M = cd\frac{T_k}{p_k[1 + \sqrt{1 - m} - \frac{1}{2}(1 - m)]^3}$, c being $\frac{v_k \cdot p_k}{T_k}$ and $d = \frac{M}{v}$. For non-associating liquids this expression for M gives approximately constant values for k, the mean value being 22·5 at 0°. The deviations from the mean value are of similar magnitude to those of Berthelot's constant, and the equation may thus be used for calculating the molecular weights of non-associating liquids as far as the critical temperature, but gives high values in the case of associated compounds. At the critical point c is about double Berthelot's constant. T. H. P.

SOUND.

1871. *Propagation of Sound in the Atmosphere.* **E. Wiechert.** (Meteorolog. Zeits. 43. pp. 81–91, March, 1926.)—The author deals generally with the waves resulting from large explosions at the earth's surface, the inner and outer regions of audibility, the zone of silence and the dimensions of these regions. Facts relative to eight cases have been collected and examined in some of which one or other of these regions was not located. Normal and abnormal waves are dealt with, the former occurring in the inner region of audibility, and having a rate of travel comparable with that of sound at the earth's surface, under given temperature and wind conditions, while the latter occur in the outer region and have a smaller rate of travel parallel to the earth's surface. The normal waves usually are inaudible before abnormal waves are heard. Details are supplied of optical and mechanical arrangements used to detect the waves, theoretical considerations for the travel of the sound in following or cross winds, and on the effect of changes in wind-speed or of temperature with height from the earth's surface. Abnormal waves are traced to the reflection of the sound in a layer of the stratosphere 30 km. or more from the ground, at which level the velocity of sound waves increases with height and at about 40 km. equals or exceeds the surface value. The indications of falling meteorites in the outer regions of the atmosphere are also examined. A full bibliography is given. R. S. R.

1872. *Propagation of Weak Explosive Sounds.* **T. Vautier.** (Comptes Rendus, 182. pp. 51–53, Jan. 4, 1926.)—Continuing the work of previous papers [see Abstract 808 (1926)], the intensity of the weak explosive sounds produced by electric sparks and percussion caps of a pistol are here studied. Microphones and also damped and free rubber diaphragms were used. The sounds were found to be but little diminished on reflection. W. H. Ge.

1873. *Zones of Audibility of Explosive Waves.* **W. J. Witkiewitsch.** (Meteorolog. Zeits. 43. pp. 91–96, March, 1926.)—Details are given of information collected relative to the series of heavy explosions near Moscow on May 9–10, 1920, and of the weather during this time in neighbouring parts. From these results the inner and outer regions of audibility and the zone of silence could be accurately constructed. Theoretical considerations of temperature gradient in the atmosphere lead to possible trajectories of sound waves above the ground. In the present case weather conditions point to the existence of a temperature inversion over a great part of this region, and this is used to explain the formation of the outer zone of audibility, and especially the sharp definition of the inner ring of it. R. S. R.

1874. *Architectural Acoustics.* **P. R. Heyl.** (Bureau of Standards, Circ. No. 300 [9 pp.], 1926.)—The fundamental principles governing the construction of an acoustically successful auditorium are no longer new, but are not yet generally understood by those engaged in such work. In this circular these principles are stated, and an example is worked out showing their practical application to the planning of a new auditorium or to the curative treatment of one that has proved to be unsatisfactory. AUTHOR.

1875. *On Apparatus for Investigating the Strength of Fog-signals.* **E. T. Paris.** (Journ. Sci. Instruments, 3. pp. 187–198, March, 1926.) —Apparatus is described which can be installed on board a vessel and used for the investigation and comparison of the strength of fog-signals at sea. Details of the construction and use of the sound-receiving instrument (a hot-wire microphone) and the recording apparatus are given, and a method is described whereby the ohmic changes in the resistance of the hot-wire grid can be readily interpreted in terms of a scale of sound amplitudes. An example of an acoustical survey carried out with the apparatus described is given. AUTHOR.

1876. *Ripples and Acoustical Wave Phenomena.* **A. H. Davis.** (Phys. Soc., Proc. 38. pp. 234–245; Disc., 245–246, April, 1926. Engineering, 121. p. 524, with Disc., April 23, 1926. Abstract.)—The extent of the analogy between cylindrical sound-waves and waves on the surface of a liquid is studied. It is established for inviscid media that as regards velocity potential the differential equations are similar provided the disturbance is small and is harmonic in type. It is then shown that the velocity potential in a field of inviscid surface waves may be used to represent that in a field of cylindrical sound-waves, provided the size of any obstacle bears the correct relation to the wave-length of the disturbance. In the case of a liquid having a depth greater than half the wave-length, it further follows that the height of a surface wave is a measure of the condensation of air in the corresponding acoustical condition. The effect of moderate viscosity is of the same type for sound-waves and for surface waves; it is most marked for short wave-lengths, and it decreases amplitudes without appreciably altering the wave-length. The decrease in amplitude depends upon the viscosity and the time which has elapsed since free oscillations commenced, or, for maintained oscillations, since the disturbance concerned left the source. For surface waves further damping occurs if the depth is less than half a wave-length, and the apparent viscosity may be appreciably increased by contamination of the surface by means of a film of oil of excessive thinness. Viscous effects are generally negligible in the case of sound, but they are appreciable for the water waves that would usually be used in a small ripple tank not greater than, say, 10 ft. in size. Mercury waves are much less affected by viscous damping than water waves. Experiments conducted with model obstacles in a ripple tank show that the effects of the meniscus around the obstacle and of the amplitude of the source are not important. When the water becomes stale on exposure—and presumably contaminated —the relative distribution of ripples around the obstacles is appreciably modified, but not to an extent which would correspond to any very marked change in the loudness of a sound. Experiments have also been conducted, outside the limits of strict mathematical analogy, using an impulsive disturbance instead of a maintained train of waves. When it is recognised that a sound-pulse travels out singly, whereas with ripples subsidiary wavelets accompany the main pulse, the correspondence between ripple photographs and sound-pulse photographs is most striking. Illustrations are given of the use of a ripple tank in connection with architectural acoustics and of its general value where wave phenomena are concerned. In the *Discussion,* the two-dimensional solutions given for cylindrical waves in the paper do not necessarily give safe guidance in the case of three-dimensional problems. G. A. S.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

1877. *Invariant Expressions in the Electrodynamics of Moving Systems.* **H. Malet.** (Comptes Rendus, 182. pp. 1136–1138, May 10, 1926.)—Maxwell's equations, together with the postulate of relativity applied to the electromagnetic field observed in two systems moving with relative velocity v, lead to the invariance of the expressions $E^2 - H^2$ and $\frac{1}{8\pi}\{E^2 + H^2\} - (v, P)$, where P is Poynting's vector. The author considers the form of the latter inconsistent with the objective allocation of energy. He is led, starting from relations given recently by Ferrier, to the following forms for the total electromagnetic energy and a generalised Poynting vector: $8\pi W = E^2 + H^2 - A^2$, and $P = \frac{1}{4\pi c}\{[E, H] + AE\}$ respectively, where A is the "ampérien" function introduced by Ferrier. W. S. S.

1878. *Forces on a Rigid Magnetised Conductor.* **E. H. Kennard** and **S. C. Wang.** (Phys. Rev. 27. pp. 460–469, April, 1926.)—The forces on magnetised material carrying current are examined from the standpoint of the electron theory. The true distribution of forces depends upon the minute structure of the material and so is at present unknown in the general case; it is even doubtful whether the partial force on the current alone is $j \times B$. For a rigid body two sets of forces equivalent to the unknown actual ones are obtained: the first set consists of a force per unit volume equal to $\nabla_H(I \cdot H) + j \times B$, together with an additional torque per unit volume $I \times H$; the second consists simply of a force per unit volume equal to $mH + j \times H$, (H = magnetic intensity, B = induction, j = current density, I = intensity of magnetisation, m = free pole density). The first set may resemble the actual forces somewhat more closely than the second, but the second set is so much simpler that it is recommended for general adoption. If a set of stresses is preferred to body forces, the set commonly used is recommended, which consists of a tension along the tubes and a pressure perpendicular to them, each equal to $\mu H^2/8\pi$, with no assumption whatever as to the stresses in rigid bodies where μ does not have a constant value: this set corresponds to neither of the laws of force. The rotating-magnet experiment recently repeated by Zeleny and Page [Abstract 633 (1925)] is discussed, and the torque is ascribed by preference to forces on the free poles. AUTHORS.

1879. *Note on "Forces on a Rigid Magnetised Conductor."* **J. Zeleny** and **L. Page.** (Phys. Rev. 27. pp. 470–473, April, 1926.)—In reply to the criticism by Kennard and Wang [see preceding Abstract] of our theory of the torque on a cylindrical magnet through which a current is passing [Abstract 633 (1925)], it is pointed out that there is a rational distinction between the torque exerted by the current on the magnet and that exerted by the magnet on the current passing through it. From the point of view of Ampere's theory of magnetism, the first torque is zero and the second is $iN/2\pi$, in electromagnetic units, both for the case of a symmetrical current sheet and asymmetrical magnetisation and for the case of symmetrical magnetisation and an asymmetrical current. Therefore on the modern conception that magnetic properties are due to electric currents and not to magnetic charges *per se*, the torque on a cylindrical magnet carrying a current cannot correctly be ascribed to the action of the current on the magnet in either of the two cases under discussion, contrary to the contention of Kennard and Wang. AUTHORS.

1880. *Phenomena due to the Passage of a Bar-magnet through a Circular Coil.* **E. E. Witmer.** (Frank. Inst., J. 201. pp. 91–106, Jan., 1926.)—The author investigates the e.m.f. induced in a circular coil by a moving magnetic pole which has a uniform velocity along a line inclined to the axis of the coil by a small angle and passes through the coil at a short distance from its centre. Formulæ are then obtained for the case of a magnet whose motion is (*a*) in the direction of its axis, (*b*) inclined to its axis. He also describes experiments undertaken to verify the theory of a previous paper in which a magnet is allowed to fall vertically along the axis of such a coil, the circuit of which was magnetically coupled by an air-core transformer. [See Abstract 1530 (1924).] The oscillogram records of the primary and secondary currents agree well with the computed curves and reveal differences which are in accord with the conclusions stated in the previous paper. W. C. S. P.

1881. *The Force between Moving Charges.* **V. Bush.** (J. Math. Phys., Mass. Inst. of Technology, 5. pp. 129–157, March, 1926.)—The author develops a theory of the force between moving charges, originally treated by Gauss and Weber, with a suggestion that it may offer an alternative line of approach which may possibly bring together some matters now widely divergent in our theories. It involves a variant charge and an invariant mass, and so is contrary to restricted relativity. He claims that it leads to all our laws of electric circuits without the agency of a magnetic field. Some of the immediate objections to this scheme of attack are discussed. It is considered in the light of the Kaufmann-Bucherer results. Applied to atomistics it gives the same results as were obtained by Sommerfeld for fine structure by the use of restricted relativity. It gives, for an electron revolving about a nucleus, a critical diameter within which the electron may become imprisoned, and this diameter is computed to be of the order of magnitude believed experimentally to be the diameter of the atomic nucleus. G. W. DE T.

1882. *Electric Moment of CO_2, NH_3, and SO_2.* **C. T. Zahn.** (Phys. Rev. 27. pp. 455–459, April, 1926.)—By an improved heterodyne null method previously described [see Abstract 608 (1925)], measurements were made of the dielectric constant at atmospheric pressure of the carefully purified gases over a range from 300° to 400° from just above the liquefaction point. These results, as well as all others found by the author, are represented by the Debye equation $(\epsilon - 1)vT = AT + B$, where ϵ is the dielectric constant, T the absolute temperature, and v the specific volume. The values found for A are 0·000958 (CO_2), 0·000768 (NH_3), and 0·001433 (SO_2); and for B are 0·003 (CO_2), 1·740 (NH_3), and 2·167 (SO_2). The anomaly observed by Jona and attributed to association was not observed except possibly to a slight degree in NH_3. The values of the electric moment of the molecules calculated from the constant B differ from Jona's values by 7 %. It is believed that the explanation of the difference is to be based on the fact that the anomaly is not due to association but to surface effects on the metallic plates of the condenser. The values obtained for the electric moment are, in c.g.s., e.s. units × 10^{18}, 0·06 (CO_2), 1·44 (NH_3), and 1·611 (SO_2). The small value for CO_2 differs from zero by an amount which is less than the experimental error.

AUTHOR.

1883. *Formation of Drops in an Electric Field.* **L. Abonnenc.** (Comptes Rendus, 182. pp. 1031–1033, April 26, 1926.)—The diminution in weight of drops formed at the extremity of a cylindrical tube, under the influence of variously disposed electric fields, is studied, and it is noted that its amount decreases with liquids more nearly approaching perfect dielectrics. It is concluded that the effects are not due to alteration by the electric field of the viscosity, or, in the case of insulating liquids, of the surface-tension, but are due to forces resulting from electric charges spread over the surface of the drop, and, to a less extent, to forces arising from the polarisation of the dielectric, comparable with those occurring during the formation of a drop in a magnetic field. A. B. C. L.

1884. *Lightning.* **N. E. Dorsey.** (Frank. Inst., J. 201. pp. 485–496, April, 1926.)—To explain a number of dissimilar phenomena produced by lightning a scheme is introduced to account for the lightning stroke. An electronic dart is pictured in which the foremost electrons with a velocity approaching that of light ionise the path while the laggard electrons combine with the resultant positive residues and produce the brilliant flash. As the foremost electrons are retarded, the laggard ones speed them on again, and a dart effect continues until the foremost electrons begin to lose their ionising power. At this point a rapid increase of negative charge occurs and a new dart may eventually form in the same or in a different direction. Where the dart stops an explosion occurs. The lightning stroke is not the result of a cloud discharging to earth, although the cloud does become partially discharged by the electrons or ions freed by the dart. These ideas are used to explain (1) the formation of a cavity on occasions when an object is surrounded by higher earthed conductors; (2) the breaking out of sections from a wall or roof; (3) the piercing of a hole in a pane of glass even when in a conducting window-frame; and (4) the formation of fulgurites in dry sand. R. S. R.

DISCHARGE AND OSCILLATIONS.

1885. *Over-tension in Condenser Battery during Sudden Discharge.* **P. Kapitza.** (Cambridge Phil. Soc., Proc. 23. pp. 144–149, April, 1926.)—In experiments on the Zeeman-effect [Abstract 2502 (1925)] a battery of thirty-two Leyden jars in parallel with a capacity of 0·1 microfarad was used to obtain an intense light source of short duration. The discharge through a small spark-gap was effected by means of an oil-immersed switch. Sometimes, after the battery had been charged to its maximum tension and the switch put into operation, only a small spark occurred at the spark-gap, the main discharge going over the top of the insulators of one of the Leyden jars. Photographs taken on a rapidly moving film showed that about twenty complete oscillations occurred in the normal discharge at the spark-gap, while the discharge across the insulators caused the spark at the gap to be extinguished after only one or two half-oscillations. Discussion of these effects shows them to be connected with the fact that the self-induction of the connecting leads and Leyden jars was of the same order as that of the spark circuit. Formulæ are derived for the over-tension and for the condition that the maximum over-tension may occur after the nth half-oscillation. In general it is seen that such over-tensions can be avoided by connecting the spark-gap circuit to opposite ends of the condenser battery. A. W.

1886. *Gaseous Combustion in Electric Discharges. Part I. The Combustion of Electrolytic Gas in Direct-current Discharges.* **G. I. Finch** and **L. G. Cowen.** (Roy. Soc., Proc. 111. pp. 257–280, May 1, 1926.)—Combustion in an electric discharge is confined to the kathode, up to a certain limiting current, the rate of combustion being directly proportional to the current and depending on the nature of the kathode material. At a certain limiting current, combustion commences abruptly in the inter-electrode zone, and proceeds simultaneously with and independently of the kathode combustion. This inter-electrodic combustion depends on the current flowing, on the gas pressure and the degree of separation of the electrodes. No combustion takes place in the anode zone. Combustion appears to be determined primarily, therefore, by the ionisation of the gaseous medium through which the current is passed, and the abrupt superposition of the inter-electrodic combustion suggests a quantum effect. B. W. C.

1887. *Theory of Current Transference at the Kathode of an Arc.* **J. Slepian.** (Phys. Rev. 27. pp. 407–412, April, 1926.)—The relatively low temperature of the kathode in the case of such metals as copper and mercury suggests that thermionic emission from the kathode is not essential, and that some other factor may be more important in determining the current carried to the kathode in such cases. It appears that if the gas next to the kathode is sufficiently hot, thermal ionisation in accordance with Saha's equation may account for much of the current to the kathode. Calculation shows that an upper limit for the required temperature is somewhat in excess of 4000° K. for Ca, and 6000° K. for Cu. AUTHOR.

1888. *Low-voltage Arc in Cæsium Vapour.* **F. H. Newman.** (Phil. Mag. 1. pp. 705–711, April, 1926.)—In previous papers [Abstracts 2294 (1925) and 297 (1926)] it has been shown that the normal operation of an arc in sodium and potassium vapours results in the excitation of a line-by-line spectrum corresponding to changes of orbit involving less energy than the ionising potential. The present work describes similar experiments with cæsium vapour. A discussion is first given of the results obtained by Foote and Meggers and by Hughes and Hagenow, reference being made to a graphical representation of the cæsium atom. The spectrograms obtained show the doublet $\lambda\lambda 8943$, 8521 at 1·6 volts, followed by $\lambda\lambda 4593$, 4555 at 2·7 volts. No additional lines appeared on the plate till 3·2 volts were reached, when the lines $\lambda\lambda 7944$, 7609, 3889 and 3876 were photographed. $\lambda\lambda 7944$, 7609 probably appeared below 3·2 volts, but were too weak to be recorded. No additional lines were found until the ionisation voltage, 3·9 volts, was reached, when the entire arc spectrum was excited, but the evidence is in favour of a line-by-line excitation through the region 3·2 to 3·9 volts. A. W.

1889. *Spark Lag.* **E. Regener.** (Zeits. f. Physik, 36. 8. p. 581, 1926.)—A short discussion of the work on the subject by W. Hiller [see Abstract 1892 (1924)]. The experiments of Braunbek [see next Abstract] and the previous work of Zuber [see Abstract 1173 (1925)] also receive brief mention. A. E. G.

1890. *The Dependence of Spark Lag on Tension and Ionisation.* **W. Braunbek.** (Zeits. f. Physik, 36. 8. pp. 582–604, 1926.)—Conditions are here investigated under which good results are obtained for the time of lag which elapses between putting on the tension and the passage of the spark. The statistical distribution of the value of the lag is determined and found with different arrangement of electrodes, different tensions, and different ionisations, in accord with the relation $n_t = k \cdot \varepsilon^{-kt}$, which was first pointed out by Zuber for an essentially lower pressure region. The mean value of the statistical distributed lag-times shows a dependence on tension and ionisation which may be approximately expressed as follows: The product of the mean lag, tension, and total ionisation is a constant for a given condition of the spark tract and gases. The direct contradiction between this law and the results of Hiller is explained by the proof of error in the experimental arrangements in the Hiller measurements. [See preceding Abstract.] A. E. G.

1891. *Secondary Electrons from Iron.* **H. E. Farnsworth.** (Phys. Rev. 27. pp. 413–422, April, 1926.)—Secondary electron emission from iron as a function of energy of primary electrons, 0 to 300 volts.—Curves showing the ratio of the secondary to the primary electron current as a function of the primary velocity were obtained with three forms of apparatus. Two have been previously described. The limiting curves obtained after red-heat treatment of samples of electrolytic Fe having very large crystals, and of chemically pure Fe obtained from Kahlbaum were similar to those obtained for a film of Fe deposited by evaporation. The curves all have sharp maxima at 1·2 and 7·0 volts with minima at 3·7 and 12·0 volts, and a less prominent maximum and minimum at 10·0 and 9·0 volts, respectively. Of several metals tried, Fe is the only one, in addition to Cu, for which such sharp maxima and minima have been obtained. Potentials corresponding to positions of the maxima are interpreted as critical potentials. A steady upward trend of the curve begins at 12·0 volts, which is interpreted as being due to ionised electrons. Slight changes in slope of the curve at higher potentials were observed, but these varied with conditions, and hence are taken to have no real significance. Evidence of structure of evaporated Fe film.—While previous results for Cu indicate that a layer deposited by evaporation is amorphous, the present results indicate that a similarly formed layer of Fe is crystalline. AUTHOR.

1892. *The Resonance Potentials of Helium and Double Impacts by Electrons in Helium.* **G. Glockler.** (Phys. Rev. 27. pp. 423–431, April, 1926.)—First and second critical potentials in helium.—A tube with five platinum electrodes was used to determine the first two critical potentials in carefully purified helium. The inelastic impact method of Franck was used over a pressure range from 0·13 to 13·00 mm. and gave values of 19·87 ± 0·06 for the first and 20·62 ± 0·06 volts for the second critical potential. The method of Lenard for pressures from 0·96 to 2·85 mm. gave values of 19·83 ± 0·02 and 20·57 ± 0·06 volts. The spectroscopic value corresponding to the transition $1S \longrightarrow 2s$ (A) is 19·77 volts and that corresponding to $1S \longrightarrow 2S$ (B) is 20·55 volts. The observed difference between first and second critical potentials, 0·75 (Franck method), 0·74 volts (Lenard method), is in excellent agreement with the spectroscopic value of the difference B − A, 0·78 volts. The average initial velocity correction was determined by two different methods which led to concordant results.

Critical potentials in helium due to double impact.—Three critical potentials in helium near 40 volts were observed by the Franck method. The values are 39·62, 40·47 and 40·96 ± 0·04 volts, the last being the most prominent. The spectroscopic values for double impacts are 39·54 volts ($1S \longrightarrow 2s$ and $1S \longrightarrow 2s$), 40·32 volts ($1S \longrightarrow 2s$ and $1S \longrightarrow 2S$), and 40·89 volts ($1S \longrightarrow 2s$ and $1S \longrightarrow 2P$). The observed difference between the first critical potential and the most prominent double-impact point is 21·09 volts, in excellent agreement with the spectroscopic value of the transition $1S \longrightarrow 2P$, 21·12 volts. AUTHOR.

1893. *Variations of Thermionic Current with Distance of Anode.* **T. V. Jonescu.** (Comptes Rendus, 182. pp. 1016–1018, April 26, 1926.)—A platinum wire 6 mm. long and 0·1 mm. dia., coated with lime, was used as kathode and a metal disc as anode. The distance of the latter could be varied by a micrometer screw. The variation of thermionic current at 60, 120 and 180 volts was plotted with constant potential difference at the ends of the wire. The proximity of the anode caused the temperature of the filament to vary, and curves are given showing the effect at constant kathode temperature. The method is suggested for tracing the nodal lines of vibrating plates used as anodes. F. S.

1894. *Theory of the Thermionic Effect. I.* **N. v. Raschevsky.** (Zeits. f. Physik, 36. 8. pp. 628–637, 1926.)—In a previous publication [see Abstract 2579 (1925)] the author attempted to treat the electronic and ionic emissions from glowing bodies from the standpoint of the phase rule, and this work is now extended without making any special assumptions as to the characteristic function ϕ_2 of the solid phase. It is found that the influence of pressure upon the thermionic current is very small and may be neglected at the same degree of approximation with which the ratio n^+/n^- of the number of positive ions in the metal to that of the electrons is assumed independent of the temperature. An expression is given for the free energy of the solid phase which is derived by avoiding as far as possible any special hypothesis concerning the electrons within the solid phase. This expression for the free energy enables a formula to be derived for the thermionic current from the general formula, which may lead to the evaluation of deviations of the A-constants in Richardson's formula from the universal values postulated by Dushman in the cases of oxides and adsorbed metallic layers. The paper is mathematical throughout. H. H. Ho.

1895. *Diffusion of Electrons.* **G. Glockler.** (Nat. Acad. Sci., Proc. 4. pp. 178–180, March, 1926.)—In order to calculate the efficiency of resonance it is necessary to know the average number of impacts Z that an electron makes in traversing a layer of gas when there is no field. The calculation of the quantity Z is given in this paper. The average number of collisions which an electron makes when diffusing through a gas, a distance a, when no field is acting on the electron is calculated to be $3/2(a^2/\lambda^2)$. λ is the mean free path of the electron. The number of impacts is seen to be independent of the velocity of the electron.

A. E. G.

1896. *Effect observed with Platinum when bombarded with Slow Electrons.* **E. Rudberg.** (K. Vetenskapsakad. Nobelinst., Medd. 6. 12. pp. 1–9, 1925. In German.)—In a glass apparatus provided with a short incandescent filament, a flat grid near the filament and a platinum anode parallel to the grid, it was found that the anode current (measured by a galvanometer) always increased when the anode was illuminated by light from various sources, falling to its original value when the light was removed. The apparatus was highly evacuated. With a second tube specially constructed to observe the reflected electrons it was found that the effect of illuminating the platinum anode was always to reduce the reflection. The dependence of the effect on the velocity of the primary electrons is not very great. The relative variation of the current from the platinum is practically constant from 4 to 12 volts, with a very flat minimum about 8 volts. Beyond 12 volts the relative variation increases, but the percentage change of the secondary emission when light is allowed to fall on the surface of the platinum is of the same order of magnitude for the whole range of primary velocities used. The effects observed were, within the limits of error, proportional to the quantity of light falling on the surface of the platinum. The intensity was only varied in the ratio 1 : 4. The colour of the light used appeared to make little or no difference. This can be satisfactorily explained if the effect of the light is regarded as a thermal action on the process of secondary emission.

A. W.

1897. *Anamalous Dispersion and Absorption of Electric Waves.* **S. Mizushima.** (Chem. Soc. Japan, Bull. 1. pp. 47–53, March, 1926.)—Experiments were carried out by a resonance method to find the absorption and apparent dielectric coefficients for various liquids at temperatures between 63° and − 89° C. The liquids were introduced into a container provided with electrodes. This was arranged in parallel with a calibrated variable condenser in the resonance circuit, the absorption being measured by the ratio of the resonance currents (*a*) with no liquid and (*b*) with liquid in the container. The wave-length used in the experiments now described was 6·1 m. With distilled water, acetone, benzene, and mixtures of acetone and water and of acetone and benzene no change of resonance current was observed at ordinary temperatures. With glycerine the apparent dielectric constant reaches a maximum value near ordinary room-temperatures, and as the temperature is reduced, it then decreases till it reaches a value almost equal to the square of the refractive index for visible light. The resonating current decreases as the temperature is lowered, passes through a minimum value, and finally reaches equality with the current found without liquid in the container. Of the alcohols used, ethyl, propyl, isopropyl, butyl, isobutyl and amyl alcohols give results, in general, similar to those obtained with glycerine. Methyl alcohol gives no maximum of dielectric constant down to − 84° C., but the results indicate the approach to a maximum occurring at a lower temperature. A. W.

1898. *Characteristics of Shielded-grid Pliotrons.* **A. W. Hull** and **N. H. Williams.** (Phys. Rev. 27. pp. 432–438, April, 1926.)—The internal "feed-back" from plate to grid of a pliotron is prevented by electrostatically shielding the two from each other. Specially designed tubes, thus shielded, are described. The capacity between plate and control grid was found to be only 0·006 $\mu\mu$F in the best models. These tubes may, therefore, be expected to behave as strictly unidirectional devices at all frequencies, which was found to be true. Plate-resistance characteristics are given, and it is shown that the internal plate conductance is negligible compared with the conductance of practical circuits. The plate current thus depends on grid voltage only, *i.e.* in place of the seven parameters of the three-element tube there is but one, mutual conductance. AUTHORS.

1899. *Measurements of High-frequency Amplification with Shielded-grid Pliotrons.* **A. W. Hull.** (Phys. Rev. 27. pp. 439–454, April, 1926.)—Tests of cascade high-frequency amplification are described, using specially constructed tubes in which the control grid is electrostatically shielded from the plate. These tubes are free from internal feed-back, so that any number may be operated in series. The voltage amplification per stage depends only on the circuit impedance, and was found to be 200 at 50 kilocycles, 40 at 1000 kc., and 7 at 10,000 kc. Total amplifications as high as 2,000,000 in voltage were obtained and measured at 1000 kc. It is shown that this is the largest amplification that can be usefully employed at any frequency. At 10,000 kc. a total amplification of 10,000 was obtained. Examples are given of other applications, such as the amplification of small photoelectric currents, where shielding is advantageous. AUTHOR.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1900. *Conductivity of Mixtures of Strong Electrolytes.* **H. Egnér.** (K. Vetenskapsakad. Nobelinst., Medd. 6 5. pp. 1–8, 1926. In English.)—Measurements of the conductivities of mixtures of HCl, LiCl, NaCl, KCl, $MgCl_2$, and $CaCl_2$, in concentrations ranging from 0·1 to 0·002 n., and of these electrolytes alone in the same range of concentration. The conductivities of the mixtures were calculated, by aid of the isohydric principle, from the conductivities of the latter solutions. The calculated conductivities were always greater than the experimental ones, when they were greater than the experimental errors. The experimental errors were in excess of the difference between the calculated and determined values only in the type acid-salt, and it tended to disappear at small concentrations. The viscosity correction changed the computed values in a favourable direction. F. J. B.

1901. *Electrical Conductivity in the Individual Crystal and in Crystalline Aggregates.* **A. Smekal.** (Zeits. f. Physik, 36. 4. pp. 288–291, 1926.)—Joffé and Zechnowitzer's conclusion that the microcrystalline structure of formed crystals does not suffice for the electrolytic conductivity

[Abstract 1101 (1926)] is not justified. All the experimental results of these authors agree with the consequences of the surface theory of the electrolytic conduction of the current in crystalline substances [see Abstract 455 (1926)]. T. H. P.

1902. *Electrical Conductivity of Single Crystals and Crystal Aggregates.* **G. v. Hevesy.** (Zeits. f. Physik, 36. 7. pp. 481–483, 1926.)—A short note on the work of Joffé and Zechnowitzer [Abstract 1101 (1926)] on the conductivity of plastically deformed NaCl crystals. The question is dealt with from the point of view of the "Auflockerung" (loosening) of the crystal gratings. A. B. W.

1903. *Contact Resistance.* **E. Friman** and **R. Holm.** (Zeits. techn. Physik, 7. 4. pp. 198–200, 1926.)—Measurements have been made of carbon contact resistance at different temperatures in a vacuum. The resistance diminishes at first slowly, then more rapidly with increasing temperature, falling from its normal value at 0° C. to about 1/5th at 1000° C. The decreased resistance is ascribed to the increase of area of contact as the temperature of the carbon contact rises. A. B. W.

1904. *Unipolar Conductivity in Rectification Effects.* **K. Ippisch.** (Phys. Zeits. 27. pp. 199–202, April 1, 1926.)—Extended reference is made to previous work on the unipolarity of crystal contacts by Streintz and Wessely [see Abstract 1480 (1920)], who defined the polarity U as $U = \frac{i_1 - i_2}{i_1}$, where i_1 and i_2 are the current values in different directions across such crystalline contacts, and who showed the constancy of the product UV, where V is the charging potential. The present author gives tabulated values for these quantities for the following crystal combinations: natural zinc oxide/steel, silica/steel, lead glance/carborundum, zinc oxide/lead glance, chaleopyrites/zinc oxide, and finds the previous author's results confirmed within the limits of experimental error. Attention is drawn to similar results in electrolytic rectifying cells, and it is considered that the phenomenon in this case at the surface gas layer is essentially similar to the phenomenon at the gas layer of crystals. B. J. L.

1905. *Variations in the Photoelectric Sensitivity of Platinum.* **L. A. DuBridge.** (Nat. Acad. Sci., Proc. 12. pp. 162–168, March, 1926.)—Even after prolonged heat treatment in the highest attainable vacuum a clean platinum surface is still slightly sensitive to the radiation from a quartz mercury arc, and gives a measurable photoelectric emission. The long wave-length limit after prolonged outgassing lies between 1943 and 1973 Å.U. After prolonged heat treatment the photo-currents settle down to stable values which are characteristic of the temperatures. G. A. S.

1906. *Luminous Piezo-electric Resonators as High-frequency Standards.* **E. Giebe** and **A. Scheibe.** (Elekt. Zeits. 47. pp. 380–385, April 1, 1926. From the Reichsanstalt.)—The quartz rod resonators previously described [Abstract 2594 (1925)] may be used conveniently as high-frequency standards, the optical methods of determining the resonance conditions being quite sensitive. Further details are given of the arrangements used. An 8-cm. quartz rod gave frequencies from 34,054·5 to 708,095, and all the odd harmonics up to the 21st were observed. Photographs of the glow obtained with the third, ninth, fifteenth and twenty-first harmonics are given. A. W.

1907. *A Thermo-electric Manometer for Low Pressures.* **E. Rumpf.** (Zeits. techn. Physik, 7. 5. pp. 224–226, 1926.)—The author extends his investigations on the Benedick effect [see Abstracts 638 (1924) and 152 (1925)] to the production of a low-pressure manometer. It consists of a platinum spiral heated by an electric current, and surrounding a thermo-element consisting of copper and constantan wire stretched within a T-shaped glass tube, which is connected to the pressure under measurement; the temperature of the spiral is accurately determined from a resistance measurement, for which purpose the spiral is made to form one arm of a Wheatstone bridge. By means of a calibration curve the instrument can be used for pressure measurements from 3 to 10^{-4} mm. of mercury. The advantages over the McLeod manometer are that it records pressures immediately and continuously, and can be used directly at the point where the pressure is to be measured. E. T. A. R.

1908. *Valve Voltmeter with Self-contained Batteries.* **C. R. Cosens.** (Journ. Sci. Instruments, 3. pp. 181–187, March, 1926.)—A description is given of a voltmeter of the Moullin grid-rectification type [Abstract 1219 (1923)] in which all the necessary batteries are contained in the instrument case. A Marconi-Osram D.E.7 four-electrode valve is used with a 2-volt accumulator and an 18-volt anode battery. Details are given of the construction of the instrument, with values of the various components. A. W.

1909. *A Natural Limit for the Sensibility of Galvanometers.* **G. Ising.** (Phil. Mag. 1. pp. 827–834, April, 1926.)—Discusses the small perpetual fluctuations of the zero position of a Moll galvanometer, the sensibility of which was magnified 25 to 100 times by means of the Moll-Burger thermo-relay, and which these authors ascribed to microseismic perturbations. It is shown by means of a mathematical treatment of the problem and an examination of a magnified photograph of one of the curves published by Moll and Burger that most of these fluctuations were due to the Brownian motions of the suspended system theoretically announced by v. Smoluchowsky. H. N. A.

ALTERNATING CURRENTS AND MAGNETISM.

1910. *Contribution to the Theory of Ferromagnetism.* **G. S. Mahajani.** (Cambridge Phil. Soc., Proc. 23. pp. 136–143, April, 1926.)—A summary of a paper to be published. It is a contribution to the theory of ferromagnetic crystals, and contains a theoretical explanation of Webster's experimental results [see Abstract 1744 (1925)]. Two types of crystals are considered, *viz.* iron with cubic structure, and pyrhotite with non-cubic structure. Part I is devoted mainly to explaining Webster's results; Part II deals with non-cubic structures; and in Part III an attempt is made to extend the theory to non-saturation states. The investigation shows that if a start is made from the bulk-conception of a molecular field a third-power law is required in the case of cubic structures, and not a fourth-power one as suggested by Webster. G. E. A.

1911. *New Experiments on a Magneto-electric Directive Effect.* **P. Debye.** (Zeits. f. Physik, 36. 4. pp. 300–301, 1926.)—It might be considered possible to direct molecules which possess an electric moment and are at the same time paramagnetic, either by an electric field and so produce a magnetic moment, or by a magnetic field and so produce an electric moment. Perrier and Staring [Abstract 662 (1924)] failed to obtain results in this direction, and the author's experiments also yield negative results. If this always proves to be the case, it will seem probable that Langevin's theory of paramagnetism does not correspond with the true molecular picture. T. H. P.

1912. *Effect of Complex Ion Formation on the Magnetic Susceptibility of Paramagnetic Salts in Aqueous Solution.* **S. S. Shaffer** and **N. W. Taylor.** (Am. Chem. Soc., J. 48. pp. 843–853, April, 1926.)—Measurements are made, by Gouy's method of weighing, of the effect on the susceptibility of nickelous chloride and bromide and cupric nitrate and bromide of adding various diamagnetic substances to them. It is concluded that the formation of a chemical bond lowers the susceptibility of a paramagnetic ion, and that the lowering is proportional to the firmness of the bond formed. G. E. A.

1913. *The Magnetic Properties of Odd Molecules.* **N. W. Taylor.** (Am. Chem. Soc., J. 48. pp. 854–859, April, 1926.)—The subject-matter is the same as in an earlier paper. [See Abstract 176 (1926).] G. E. A.

1914. *The Atomic Character of Magnetism.* **W. Gerlach.** (Archiv f. Elektrot. 16. pp. 1–12, April 6, 1926.)—The present paper is a survey of the present theory of magnetism. It contains no new results, but it gives an interesting account of the work of Gerlach and Stern on the experimental proof of space quantisation of atoms. These experiments do not, however, throw any light on the problem of ferro-magnetism, which appears to be of crystalline origin. A. A. D.

1915. *Uniformity of Magnetisation of Baked Clays.* **R. Chevallier.** (J. de Physique et le Radium, 7. pp. 92–96, March, 1926.)—This paper contains a study of the orientation of the permanent magnetisation of bricks. The uniformity of this magnetisation has been established and is found to be independent of shock, while its orientation has been shown to possess a constant angle for the same batch of bricks which is very different from the magnetic inclination at the time of baking, a result as yet inexplicable. H. H. Ho.

1916. *The Magnetic Properties of Rare Earth Oxides.* **E. H. Williams.** (Phys. Rev. 27. pp. 484–486, April, 1926.)

1917. *Construction of a High-sensitivity Instrument for Earth Magnetic Measurements.* **J. B. Ostermeier.** (Zeits. techn. Physik, 7. 5. p. 223, 1926.)—This is a short description of a magnetic universal variometer, and the method of taking measurements of the horizontal and vertical intensities of the earth's field and the declination. [See Abstract 1392 (1925).] E. T. A. R.

1918. *Studies concerning the Relation between the Activity of the Sun and of the Earth's Magnetism.* **L. A. Bauer** and **C. R. Duvall.** (Terrest. Magn. 30. pp. 191–213, Dec., 1925.)—The variability with sunspot activity of the quantities a and b in the formula $Q = a + bS$, of the Wolf type, is investigated; Q is the quantity measuring the activity of the earth's magnetism and S is the measure of solar activity. Using annual values of Q and S it is found that a varies directly and b inversely with sunspot activity. At first the Wolf-Wolfer sunspot numbers are used as measures of solar activity, but later other solar measures, sunspot area, faculæ, umbræ, flocculi, prominences and solar-constant values are utilised. While the correlation coefficient r for a year-to-year comparison between various kinds of solar and magnetic measures reaches values as high as 0·94, the comparison from month to month or from day to day may yield a value below 0·5, even after every care is taken to eliminate annual periodicities in the solar and magnetic measures. In fact, none of the present measures of solar activity explain satisfactorily the various phenomena of the earth's magnetic activity on the assumption that there is a direct causal connection between sunspots and the earth's magnetic disturbances. A. A. D.

1919. *Review of G. W. Walker's Magnetic Survey* **(1915). A. Schuster.** (Roy. Soc., Proc. 111. pp. 68–82, May 1, 1926.)—The whole of Walker's material has been recalculated, applying the method of least squares instead of previous simplified procedure to obtain information regarding the distribution of magnetic forces over an area sufficiently small to justify a linear representation of their variation. A decisive test can thus be applied to the existence of earth-air currents. The country was divided into nine districts, and these again each into four smaller areas, and values of the N. and W. forces found at the central point in terms of γ. A descending current was found in only one of the nine districts. The magnitude of the results is in fair agreement with those obtained by A. Schmidt from charts of Neumeyer's survey for 1885. A summary is given of further preliminary work in preparation for a further test at the next sunspot minimum. R. S. R.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

1920. *Oscillographic Records of Induction Coil Discharges.* **E. A. Owen.** (Brit. J. of Radiology, 22. pp. 49–65; Disc., 65–66, April, 1926.)—An account is given of an experimental investigation of the relation between the output of an X-ray bulb operated by an induction coil and the frequency of interruption of the primary current. Certain adjustments of the interrupter which have important bearing on the efficiency of the coil when operating different types of X-ray tubes have been studied. The importance of obtaining simultaneous records of the primary or secondary current and the secondary voltage wave-form of h.t. generating apparatus, together with a record of the X-ray output, has already been emphasised by different investigators, the work of Crowther [Abstract 1973 (1925)] being noteworthy. Similar records, together with a time curve, have been obtained in the present work and, in addition to the

X-ray bands photographed on the plate, an independent measurement of the intensity of the X-ray beam has been made with an electroscope. The paper is well illustrated with oscillographic records and contains much information of a practical nature relating to the design of interrupters. A. B. W.

1921. *A New Type of Gas Tube with Variable Penetration.* **R. J. McC. Tozer.** (Brit. J. of Radiology, 22. pp. 80–83; Disc., 83–84, April, 1926.)—A form of gas tube is described in which a third accessory ring electrode is placed between cold kathode and anode. This accessory anode is given, by means of a resistance, a negative potential with respect to the anode. The hardness or penetration of the emitted radiation in consequence varies with this negative potential and approximates, as regards control of penetration, to the separate control of this quality in the electron tube. In the *Discussion,* attention was drawn to previous experiments of this type. B. J. L.

1922. *A New Regulator for Gas Tubes.* **A. M. Codd.** (Brit. J. of Radiology, 22. pp. 85–86; Disc., 86–87, April, 1926.)—Describes a softening device of the Lindemann type in which gas is disengaged for tube softening by heating calcium carbonate by means of an electrical resistance. In this case the occluding compound is not stated, but is deposited upon asbestos. In the *Discussion,* reference was made to the use of a similar method by Lindemann. B. J. L.

1923. *The Significance of Changes in the Electrical Resistance of the Body during Sleep.* **C. P. Richter.** (Nat. Acad. Sci., Proc. 12. pp. 214–222, March, 1926.)—Reference is made to previous work upon the physiology of sleep, which has been very little studied. Depth of sleep has been measured in terms of the stimuli necessary to arouse the patient at various times, but it is well known that the time/intensity of stimulus relation varies greatly with the patient and the type of sleep, particularly if the patient is subconscious of the experiments. The present investigator has investigated sleep at intervals during its progress by the electrical resistance to a constant current. It is shown that this resistance is localised almost entirely in the skin and can be varied by puncture of different skin areas and the peripheral action of drugs as atropin. In the former case the resistance is markedly decreased and in the latter increased. "Palm-to-palm" and "back-to-back" resistance measurements were used in these experiments, and it was found that whereas the palm-to-palm resistance increases during sleep, the latter shows a small decrease. The results vary as to whether the sleep is restful, relaxed and undisturbed, or strained sleep associated with dreaming and muscular tension. These separate classes show analogous reactions and the results differ only as regards class of sleep. Experiments were also made in catatonic patients and show this is not normal restful sleep but a state associated with increased nervous tension and decreased muscular activity. The effect of nerve division on the palm-to-palm and back-to-back resistances in monkeys is described. B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1924. *Adsorption on Large Molecules in Solution.* **M. Marinesco.** (Comptes Rendus, 182. pp. 1149–1151, May 10, 1926.)—The relation between the viscosity of a suspension of small particles and that of the liquid itself was examined for rhodamine in solution in water and various monohydric alcohols. The viscosities were measured in an Ostwald viscometer having a capillary tube 0·3 mm. diameter and 140 mm. long. The temperature was accurately controlled in a thermostat. With the exception of methyl alcohol, the results showed a constant value for the expression $V_E = C\omega + V_S$, where V_E is the volume containing 1 gramme molecule, ω the molecular volume of the solvent, and V_S the volume of 1 gramme molecule in the solid state. The constant was 12 in all cases except that of methyl alcohol, for which the value 16·9 was found. F. J. B.

1925. *Detection and Measurement of the Diffusion of Adsorbed Molecules at the Surface of Solid Bodies.* **M. Volmer** and **G. Adhikari.** (Zeits. phys. Chem. 119. pp. 46–52, Feb., 1926.)—The results of earlier experiments on the growth of mercury crystals from the pure vapour at low pressures [Abstract 2317 (1925)] are explainable satisfactorily only on the assumption of the existence round the crystals of an adsorption layer of mercury molecules possessing free mobility into the surface. The experiments now described show clearly the adsorption of benzophenone molecules from a thin film of this compound by mercury drops striking the thin glass plate near to the adherent benzophenone. The frictional resistance of the adsorbed benzophenone is about 100 times less than the frictional resistance in aqueous solution. T. H. P.

1926. *Duration of the Transient State in the Settling of Small Particles.* **W. Weaver.** (Phys. Rev. 27. pp. 499–503, April, 1926.)—The general theory of the settling of small particles in a fluid is used to determine an upper limit for the time required to establish the steady, exponential distribution of density. It is shown that the steady state will, in any case in which the initial distribution of particles is uniform, be sensibly attained in that length of time required by one of the particles, moving with the velocity given by Stoke's law, to fall two tube lengths. An examination of Burton's experiment (which sought to prove that the exponential distribution law holds for only very small depths below the surface) indicates that the steady state should have been reached in about 37 days [see Abstract 1787 (1922)]. His failure to find any evidence of an exponential distribution of density after 50 days cannot be ascribed to an inadequacy in the time allowed for settling. AUTHOR.

1927. *Precipitation of Sols by Polyvalent Ions.* **W. W. Taylor.** (Roy. Soc. Edinburgh, Proc. 45. 4. pp. 323–333, 1925–1926.)—A systematic experimental study is made of the precipitation of ferric hydroxide sol by the trivalent anions of potassium methane-trisulphonate and sodium naphthalene-trisulphonate, and, for purposes of comparison, by NaCl, Na_2SO_4 and Na_2HPO_4. When the positive sol is added to solutions containing the normal trivalent anions there is only one zone of precipitation, which commences abruptly at a concentration of about 0·0002 n. and then persists up to high concentrations. The occurrence of two zones of precipitation separated by a zone of no precipitation, due to "reversal" of the sol in the case of Na_2HPO_4, appears to be due to the presence of OH′, produced by the hydrolysis of the salt. Well-marked variations, of a more or less periodic nature, in the rate of precipitation occur when the concentration of the salt is steadily increased. These disappear with time as precipitation approaches completion. They are more marked at low concentrations. The valency rule, which connects the precipitating power of an ion with its valency, does not hold in the case of the normal trivalent anions of the two trisulphonic acids examined. A. B. C. L.

1928. *Studies with the Microbalance. Part III. Filtration and Estimation of Very Small Amounts of Material.* **E. J. Hartung.** (Chem. Soc., J. pp. 840–848, April, 1926.)—The errors of adsorption, mechanical losses, solubility of precipitates on the results of estimation of very small quantities of material were investigated. The Steele-Grant microbalance was used for the weighings. The filtration was effected in a specially designed silica crucible having a capacity of 0·3 c.c., the apparatus being contained in a dust-proof case, so that the precipitation and filtration could be carried out without contamination by falling dust. Evaporation was carried out in a vacuum apparatus heated in a glycerol bath and ignitions in an electrically heated oven. Specially purified reagents were used, and the accuracy of the method was tested by estimating the metal in silver nitrate, potassium chloride, lead nitrate, barium chloride, calcium carbonate, and the weight of salt used was below 1 mg. The results show that the method is capable of very high accuracy and use for many analytical purposes when the amount of material at disposal is small. F. J. B.

1929. *Space Lattice of some Heusler Alloys.* **L. Harang.** (Phys. Zeits. 27. pp. 204–205, April 1, 1926.)—A series of Al-Mn-Cu alloys has been examined. Three lattices have been observed. Two of these are body-centred and they are both of constant edge. One is attributed to two copper atoms and the other to an association between one copper atom and one manganese atom. The third lattice is face-centred and of variable side, which diminishes as the aluminium content increases. Of the three lattices the only one present in every magnetic sample is the body-centred type built up of manganese and copper. A. A. D.

1930. *Crystalline and Amorphous States in the Alkali Metals.* **C. C. Bidwell.** (Phys. Rev. 27. pp. 381–382, April, 1926.)—X-ray diffraction patterns obtained on a wire of metallic lithium at 20°, 80°, 110° C. show a decreasing diffracting power at the higher temperatures. This is consistent with the observations of Hull and McKeehan on sodium and potassium. The obliteration of the lattice structure at the higher temperatures is correlated with changes in the thermo-electric power and resistance lines previously found by the author for all the alkali metals. [See Abstract 1909 (1924).] AUTHOR.

1931. *Single Crystals of Aluminium under Static and Repeated Stresses* **H. J. Gough, D. Hanson** and **S. J. Wright.** (Roy. Soc., Phil. Trans.

226. pp. 1–30, April 28, 1926.)—Shows that the single crystals of aluminium possess no primitive state of elasticity; plastic strain occurs under the lowest stresses applied. This plastic strain consists of shear in the direction of a principal line of atoms on one or more of the octahedral planes of the crystal. The slip-bands which appear on the polished surfaces are the traces of these planes. The effect of slip on any plane is at first to increase its resistance to further slip; at the same time a similar hardening effect is produced on planes parallel to the original slip-planes and to a greater degree on planes intersecting the original slip-planes. Extension always taking place under reversed stresses suggests that the resistance to slip on any plane is greater when the normal stress across the plane is compressive than when it is tensile. Apart from this effect, slip in any part of a specimen appears to be confined to that octahedral plane on which the shear stress in one of the principal atomic directions is the greatest. The hardening effects in the crystals appear to be connected with a permanent distortion of the lattice of the crystal. The present work does not confirm the suggestion that this distortion may be a uniform bending of the crystal planes.

C. O. B.

1932. *Germanium in a British Mineral.* **W. Scott.** (Phil. Mag. 1. pp. 1007–1009, May, 1926.)

1933. *Contribution to the Valency Theory.* **H. Burgarth.** (Zeits. Elektrochem. 32. pp. 157–162, March, 1926.)—In explaining the valencies of the elements of the first two groups of eight of the periodic system the author assumes that the outer shell of each atom exerts four A-valencies and four opposing B-valencies, which are able to neutralise the A-valencies; the valencies of both types are non-electrical in nature. To each of the four first electrons of the outer shell is connected a B-valency and to each of the four last electrons an A-valency. With less than eight electrons in the outer shell, the valencies without electrons are free. With lithium and sodium, one B-valency is united to the electrons of the outer shell of the neutral atom, so that three B- and four A-valencies remain unbound, and hence one free A-valency after neutralisation of the A- and B-valencies. Similarly the beryllium and magnesium atoms have two free A-valencies, and so on, the free A-valencies corresponding with the normal valencies of the elements. The theory is applied to the explanation of a number of chemical phenomena of various types.

T. H. P.

1934. *Velocity-temperature Coefficient in Liquid Media.* **H. Essex** and **O. Gelormini.** (Am. Chem. Soc., J. 48. pp. 882–894, April, 1926.)—The results are given of measurements of the velocity constant of the reactions:

$$(1)\ C_6H_5\cdot N(CH_3)_2 + CH_3I = C_6H_5\cdot N(CH_3)_3I,$$

$$(2)\ C_5H_5N + CH_3I = C_5H_5NCH_3I$$

$$\text{and}\quad (3)\ S(C_2H_5)_3Br = S(C_2H_5)_2 + C_2H_5Br$$

in various solvents and at various temperatures. In nitrobenzene reactions (1) and (3) exhibit at 35° a maximum in the value of E of the expression $\frac{dlnk}{dT} = \frac{E}{RT^2}$. The value of E is, however, virtually constant for reaction (1) in benzyl alcohol, and for all three reactions in tetrachloroethane over the range 25° to 45°. The results appear to indicate that the energy of activation (critical increment) of isolated reactions in solution is independent of temperature and that deviations of E from constancy are due to abnormalities in the solvent. T. H. P.

1935. *Free Energy of Hydrogen Fluoride.* **R. A. Morgen** and **J. H. Hildebrand.** (Am. Chem. Soc., J. 48. pp. 911–918, April, 1926.)—The vapour-pressure (mm.) over fused potassium hydrogen fluoride between 226° and 348° is given by $\log p = -2150/T + 5\cdot94$. The e.m.f. of polarised electrodes in the fused salt between 223° and 272° corresponding with the reaction, $\frac{1}{2}H_2$ (1 atmos.) + $\frac{1}{2}F_2$ (1 atmos.) = HF(p atmos.), has been traced. Calculation of the free energy of the reaction forming hydrogen fluoride at 1 atmos. for the temperatures 223° to 272° and extrapolation to 25° gives the value − 32,500 cals. Use of the Latimer equation for the entropy of diatomic gases to extrapolate the value of ΔF to 25° gives for monomolecular hydrogen fluoride at 25° − 31,800 cals.; the figure given by the heat of reaction and the entropy is − 33,600 cals. The free energy of formation of $\frac{1}{6}(HF)_6$ is calculated to be − 35,000 cals. at 25°, the value − 31,800 being taken for monomolecular hydrogen fluoride. The removal of hydrogen fluoride from fused potassium acid fluoride results in the formation of a second liquid phase, nearly immiscible with the first and consisting of a dipotassium hydrogen fluoride, $HF(KF)_2$. T. H. P.

1936. *Thermal Formation of Ozone.* **E. H. Riesenfeld** and **M. Beja.** (K. Vetenskapsakad. Medd. 6. 8. pp. 1–20, 1925. In German.)—The thermal equilibrium between ozone and oxygen is best examined by investigation of the gases remaining after explosion of mixtures of the two gases. For mixtures containing less than 37 % by volume of ozone, for which the theoretical maximum temperature is 2130° abs., the residual gas appears to consist of pure oxygen; proportions of ozone having at ordinary pressure a less partial pressure than 2×10^{-8} are not detectable analytically. With mixtures containing from 45 to 94 % by volume of ozone temperatures of 2300° to 2850° are possible, and the partial pressure of the ozone after the explosion is independent of the initial concentration of the ozone and amounts to between 2 and 4×10^{-8} atmos. According to Nernst's theorem about $1\cdot3 \times 10^{-7}$ atmos. is the maximum pressure of ozone obtainable by heat in oxygen at atmospheric pressure, such pressure being reached at about 3500° abs. At higher temperatures the concentration of ozone diminishes again, the dissociation of the molecular oxygen then becoming appreciable. Only by the author's refinements in the detection of ozone has it become possible to detect the thermal formation of ozone, which has not been observed by earlier workers on the subject. [See Abstract 2625 (1925).] T. H. P.

1937. *Decomposition of Carbon Dioxide by a Condensed Spark under Reduced Pressure.* **P. Jolibois, H. Lefebvre** and **P. Montagne.** (Comptes Rendus, 182. pp. 1026–1028, April 26, and pp. 1145–1146, May 10, 1926.)—Experiments were made to determine the degree of dissociation by a spark of carbon dioxide under an initial pressure of 0·3 to 20 mm. of mercury and with capacities in the circuit ranging from 1·1 to 10·8 microfarads. [See also Abstract 406 (1926).] T. M. L.

1938. *Decomposition of Hydrogen Peroxide in Presence of Certain Suspended Hydroxides.* **Suzanne Veil.** (Comptes Rendus, 182. pp. 1028–1031, April 26, 1926.)—As with nickelous hydroxide [Abstract 1767 (1925)], decomposition of hydrogen peroxide by means of ferric or chromic hydroxide is accompanied by magnetic variation of the solid phase. It is suggested that such reactions be designated "magneto-chemical reactions." T. H. P.

1939. *Magneto-chemical Reactions of Hydroxides in Presence of Hydrogen Peroxide.* **Suzanne Veil.** (Comptes Rendus, 182. pp. 1146–1148, May 10, 1926.)—Unlike nickelous, ferric and chromic hydroxides [Abstract 1767 (1925) and preceding Abstract], cobaltous and cupric hydroxides undergo alteration in their degree of oxidation as well as in their magnetic properties when suspended in hydrogen peroxide solution. With cobaltous hydroxide, the magnetic properties of the solid phase gradually diminish as decomposition of the hydrogen peroxide proceeds, but the oxide obtained by calcining the solid phase shows progressive increase in magnetic properties and finally becomes more highly magnetic than the solid phase from which it originates. Similar behaviour is shown by cupric hydroxide, but the final solid phase and its calcined residue become equally magnetic. T. H. P.

1940. *Photochemical Reactions in Liquids and Gases.* (Faraday Soc., Trans. 21. Part 3. pp. 438–656, Feb., 1926. Zeits. phys. Chem. 120. pp. 1–319, May 5, 1926.)—A general discussion on the subject under the two headings: Part I, "Einstein's Law of Photochemical Equivalence," and Part II, "The Mechanism of Photo-chemical Reactions," comprising the following thirty-three papers: "Einstein's Law of Photochemical Equivalence" (Introductory Address to Part I), by **A. J. Allmand**; "On the Confirmation of the Einstein Law of the Photochemical Equivalence in a very Simple Photochemical Reaction," by **F. Weigert** and **L. Brodmann**; "The Relation between Quantum Sensitivity and Intensity of Radiation," by **C. Winther**; "The Law of Photochemical Equivalence and the Place of the Quantum Theory in Relation to the Atomic Theory and Energetics," by **D. Berthelot**; "Relations between the Velocity of Photochemical Reactions and Wave-length," by **P. Lasareff**; "Transformation of Atoms into Radiation," by **O. Stern**; "Flame Spectra and Chemical Reaction," by **Miss C. E. Bleeker**; "Concerning the Fundamental Laws of Photochemistry," by **I. Plotnikow**; "Einstein's Law of Photochemical Equivalence," by **N. R. Dhar** and **B. K. Mukerji**; "Note on the Radiation Theory of Chemical Reaction," by **J. Rice**; "Notes on the Influence of Radiation on Chemical Reactions," by **L. S. Ornstein**; "On the Function of Radiation in Unimolecular Reactions," by **H. S. Hirst** and **E. K. Rideal**; "A Note on the Law and Mechanism of Unimolecular Reaction," by **S. C. Roy.**

"The Mechanism of Photochemical Reactions" (Introductory Address to Part II), by **M. Bodenstein**; "Elementary Processes of Photochemical Reactions," by **J. Franck**; "The Dissociation Theory and Photochemical Thresholds," by **E. J. Bowen**; "Some Conclusions from Recent Work on Photochemistry," by **D. L. Chapman**; "Photochemical Sensitisation," by **A. Berthoud**; "Photosensitisation and the Mechanism of Chemical Reactions," by **H. S. Taylor**; "The Formation of Polar Compounds by Photochemical Reactions," by **W. A. Noyes, Jr.**; "The Yield of

Photochemical Reactions with Complex Light in comparison with that obtained with the Component Lights," by **M. Padoa**; "The Rôle of Water in the Photosynthesis of Hydrogen Chloride," by **R. G. W. Norrish**; "On Chemiluminescence," by **H. Kautsky**; "A Relation between the Velocity of Photochemical Reactions and the Dielectric Constant," by **C. Winther**; "The Photochemical and Thermal Decomposition of Ozone," by **R. O. Griffith** and **A. McKeown**; "A Suggestion on the Mechanism of the Ozone-Chlorine Reaction," by **A. J. Allmand**; "The Electron Affinity of the Halogens," by **E. B. Ludlam**; "The Physical Antecedents of the Photo-activity of Chlorine," by **W. Taylor**; "Absorption of Light by Solutions of Electrolytes," by **H. v. Halban**; "The Photolysis of Methylene Blue sensitised by Zinc Oxide," by **E. Bauer**; "The Becquerel-Effect on Copper Oxide Electrodes," by **W. J. D. van Dijck**; "Photochemical Reactions and Methods of Measuring Them," by **I. Plotnikow**; "The Mechanism of Photochemical Reactions," by **N. R. Dhar** and **B. K. Mukerji.**

"The Present Position in Photochemistry" (Summary of the General Discussion), by **E. K. Rideal.**

1941. *Influence of the Intensity of Illumination on the Velocity of Photochemical Changes. Determination of the Mean Life of a Hypothetical Catalyst.* **F. Briers, D. L. Chapman** and **E. Walters.** (Chem. Soc., J. pp. 562–569, March, 1926.)—It is remarked that some degree of discordance exists in the conclusions drawn by different workers on this subject from the results of their experiments, and the effects of illumination of various intensities on the reaction $C_2O_4K_2 + I_2 = 2CO_2 + KI$ are experimentally studied. The results agree with those obtained by Dhar and by Berthoud and Bellenot. It is concluded that when the reacting substances in solution have been exposed to light, chemical action continues for some time after the light has been shut off. The formation of an unstable catalyst (or chain of catalysts) having a life of appreciable duration is assumed. A. B. C. L.

1942. *Equilibria between Metals and Fused Salts.* **R. Lorenz.** (Am. Electrochem. Soc., Trans. 47. pp. 249–264; Disc., 264, 1925.)—From available data for the equilibria between fused salts and molten metals, two of the more simple equilibria, *viz.* $Cd + PbCl_2 \rightleftarrows CdCl_2 + Pb$ and $Cd + Tl_2Cl_2 \rightleftarrows CdCl_2 + 2Tl$ are examined in detail as to the reactions taking place and as to the effect of a diluent upon (1) the salt phase and (2) the metal phase. The effects depend much upon whether the diluent is a strictly indifferent salt or metal. The law of mass action, which holds rigidly for dilute solutions and ideal gases, does not apply to fused electrolytes, but a modified equation for the law is developed which does apply to condensed systems. In the *Discussion*, **J. D. Edwards** draws attention to the practical importance of the subject in metallurgy, citing the case of the remelting of Al under a flux of NaCl or $ZnCl_2$. A. B. C. L.

1943. *Behaviour of the Centres of Activity of Saturated Surfaces during the Initial Stages of Unimolecular Reactions.* **F. H. Constable.** (Cambridge Phil. Soc., Proc. 23. pp. 172–182, April, 1926.)—Evidence advanced indicates that, while decrease in pressure of the reactant has little effect on reaction velocity of unimolecular reaction on saturated surfaces, inert diluents cause a marked decrease. An extension of the Langmuir-Frenkel theory to the centres of activity on the catalyst accounts satisfactorily for the observations, and quantitative relations are worked out independent of the mechanism of the chemical change. If p is the fractional pressure of the reactant in the mixture and v the fractional reaction velocity, then $\frac{1}{v} = (1 - \lambda) + \frac{\lambda}{p}$, where the constant λ depends on the ratio of the molecular weights, the periods of oscillation of the perpendicular to the surface, and the heats of desorption of the two molecular species. Thus, though λ is independent of the temperature for homogeneous centres, it is independent of the temperature only if the heats of desorption of the two molecules are equal. The above expression is extended to apply to multimolecular reactions. These considerations enable the composition of the adsorbed film in contact with a given gaseous atmosphere to be derived, and furnish an explanation of the characteristic properties of catalyst poisons. If x is the pressure of the poison, then, for a unimolecular reaction, $\frac{1}{v} = 1 + \lambda x$, and for a bimolecular reaction, $\frac{1}{v} = 1 + ax + bx^2$. Since in general strong poisons have a high heat of adsorption, these expressions explain the diminished efficiency of the poison as the temperature rises. T. H. P.

1944. *New Experiments upon the Combustion of Well-dried Carbon Monoxide and Oxygen Mixtures. Part I.* **W. A. Bone** and **F. R. Weston.** (Roy. Soc., Proc. 110. pp. 615–633, April 1, 1926.)—Reference is first made to the work of H. B. Dixon, H. B. Baker, H. E. Armstrong, L. Meyer and A. F. Girvan on the subject of the ignitibility of mixtures of CO and H_2 and to the explanation of the part taken by steam in the reaction. Experiments are then described which afford new evidence on this subject. It is shown that as the water-vapour is progressively removed from a $2CO + O_2$ mixture, its ignitibility by condenser discharge sparks rapidly diminishes, the minimum spark energy necessary to fire it increasing about twenty- to thirty-fold as the gas "saturated" with water at room-temperature (about 17° C.) is dried with calcium chloride. The results connecting the condenser capacity (necessary for firing the mixture) and the percentage water-vapour are shown to lie on a smooth curve. It is also demonstrated that a six months' P_2O_5-dried $2CO + O_2$ mixture can be exploded at atmospheric pressure by a sufficiently powerful condenser discharge. Ignition was found never to occur with a "spark energy" of less than about 0·235 Joule (at 970 volts), but always occurred instantly with a spark energy of 0·362 Joule or more. The combustion, however, was never quite complete, but increased with the energy of the spark. It is concluded that there is some property of the electric spark, presumably its ionising power, which can overcome the high resistance of an extremely dry mixture to ignition and explosion. T. B.

1945. *New Experiments upon the Combustion of Well-dried Carbon Monoxide and Oxygen Mixtures. Part II.* **W. A. Bone, R. P. Fraser** and **D. M. Newitt.** (Roy. Soc., Proc. 110. pp. 634–645, April 1, 1926.)—The first part of this paper (see preceding Abstract) deals with the ignitibilities of $2CO + O_2$ mixtures, thoroughly dried for several months over re-distilled P_2O_5, and tested in a nickel-steel bomb of capacity

03 c.c. at various initial pressures up to 20 atmos. A spark-gap of 1/100 in. was employed, either from a 1-in. Marconi induction coil or from a motor-driven C.A.V. starting magneto. The results of the experiments showed that (1) at pressures below 2 atmos. none of the mixtures could be ignited; (2) at pressures from 2·75 to 5·0 atmos. the mixture could with difficulty be ignited, but 5 to 10 % of the CO remained unburnt; (3) at pressures of 10 atmos. or more the mixture ignited instantaneously, and the resulting combustion was 99 % or more complete. It is, therefore, concluded that water-vapour is not essential to the ignition of CO and O_2 mixtures. The second part of the paper contains spectrographic evidence bearing on the subject. Spectrograms have been obtained of explosion-flames of well-dried CO-air mixtures fired at initial pressures of 25 atmos. or upwards, and none of the characteristic ultra-violet "steam-lines" emitted by burning hydrogen are discernible. This evidence seems conclusive against the theory that water-vapour necessarily plays an intermediary chemical rôle in the combustion of carbon monoxide. T. B.

1946. *Gaseous Combustion at High Pressures. Part VI. The Explosion of Argon- and Helium-diluted Knall-Gases.* **W. A. Bone, D. M. Newitt** and **D. T. A. Townend.** (Roy. Soc., Proc. 110. pp. 645–659, April 1, 1926.)—Results are given of experiments upon the explosion of argon- or helium-diluted hydrogen- and CO-knall-gases at initial pressures between 10 and 150 atmos. A spherical nickel-chrome-steel bomb of 239 c.c. capacity was generally employed [see Abstract 2403 (1925)]. The mixtures used were of the type (1) $2H_2+O_2+6R$, (2) $2CO+O_2+4R$, and (3) $2CO + O_2 + 6R$, where $R =$ argon or helium. The chief objects of the experiments were (*a*) to compare the influence of two monatomic diluents of different densities on the rate of pressure development; (*b*) to furnish data for calculating the volumetric heat capacities of CO_2 and steam at temperatures above 2500° C. Amongst the results obtained it is observed that the P_m/P_i ratios were always higher with argon than with helium [$P_m =$ maximum pressure attained; $P_i =$ initial pressure); also the helium-diluted mixtures after explosion cooled at a rather faster rate than the argon. Pressure-time records and tables of results are given. The observation in a previous paper that the P_m/P_i ratios in explosions of diluted hydrogen- and CO-knall-gas mixtures always increase with the initial firing pressure is confirmed by further experiments, a percentage increase of 9 to 10 % being given when P_i is increased from 64 to 128 atmos. It is suggested that the result may be due to an increasing opacity of the gaseous medium with pressure to the radiations emitted during the explosion; spectrographic experiments are stated to support this theory. T. B.

1947. *Budde-Effect in Bromine. I. Photoactive Constituent of Wet Bromine. II. Kinetics of the Reaction and Light Absorption of Wet and of Dry Bromine.* **B. Lewis** and **E. K. Rideal.** (Chem. Soc., J. pp. 583–606, March, 1926.)—Like chlorine, bromine shows the so-called "Budde"-effect, moist bromine undergoing expansion when exposed to radiation, especially in the blue and violet portion of the spectrum, whereas dry bromine, although it absorbs the radiation, shows no such expansion [see Ludlam, Roy. Soc. Edinburgh, Proc. 44. pp. 197–201 (1923–1924)]. Experiment shows that this effect in bromine is proportional to the partial pressures of both the bromine and the water-vapour and that it is probably due to a photoactive bromine hydrate, Br_2H_2O. This hydrate is strongly adsorbed by glass surfaces, and the relationship between the concentration in the bulk and the surface phases is expressible in the form of an adsorption isotherm. The hydrate may be displaced from glass surfaces by water. When light of wave-length greater than $\lambda = 5800$ Å. is used, moist bromine fails to show the Budde-effect. The heat of formation of the hydrate is 1090 cals., which is comparable with the heat of solution of liquid bromine in water, whilst the equilibrium constant for the dissociation of bromine hydrate at 313° K is of the order of $3 \cdot 10 \times 10^9$. Marked absorption commences at $\lambda = 6100$ Å. for the wet and at $\lambda = 5700$ Å. for the dry gas, this corresponding with a lowering of the critical energy-increment of excitation by 3200 cals. The results obtained are in accord with the Stark-Einstein law of photo-equivalence, a maximum of 1·41 molecules per quantum being obtained. For the spectral region used the absorption coefficient of bromine hydrate is $10 \cdot 5 \times 10^6$, that found by Wood for mercury-vapour for the line $\lambda = 2537$ Å. It is suggested that the Budde-effect may be explained on the basis of excitation and decomposition of the molecules of the hydrate. T. H. P.

1948. *Influence of an Illuminated Mercury Surface on the Franck-Cario Reactions.* **H. S. Hirst.** (Cambridge Phil. Soc., Proc. 23. pp. 162–171, April, 1926.)—Experiment shows that illumination of a mercury surface by ultra-violet light strong in the line $\lambda = 2536 \cdot 7$ Å.U. exerts a marked influence on the photochemical union of hydrogen with gases such as oxygen, ethylene and carbon monoxide. The rate of reaction is proportional to the area of mercury exposed. The formation of a film of mercuric oxide on mercury takes place only in the presence of a mixture of hydrogen and oxygen, and various possible mechanisms for the formation are suggested. With mixtures of nitrogen and hydrogen, hydrazine and ammonia are identified in the reaction products, and with mixtures of hydrogen and oxygen, hydrogen peroxide and water have been found; the view that these reactions proceed in stages is advanced. The catalytic effect of the mercury surface depends on its cleanness and is diminished by poisons, such, for instance, as the products of the reaction in the case of the combination of hydrogen and carbon monoxide. T. H. P.

1949. *Kinetic Activation as a Factor in Gas Reactions.* **W. Taylor.** (Faraday Soc., Trans. 22. pp. 20–23; Disc., 23, Jan., 1926.)—The theory is applied according to which activation corresponds to the lifting of the electrons forming the chemical bond into orbits of higher quantum numbers together with changes in the nuclear vibrations. A generalisation to a system with any number of components is made of the expression derived by Franck and by Rice which relates the velocity of a monomolecular gaseous reaction to the activation energy and the mutual kinetic energy of the system. By employing the Maxwell distribution function the probability of collision is expressed in terms of the velocity of the molecules, and the rate of formation of activated molecules is given by an expression which reduces to $K = He^{-\epsilon/kT}$, where K is the rate of formation and ϵ is the activation energy. Though the formation of activated molecules is a necessary preliminary to chemical action, it is only in certain cases that the observed reaction rate (of production of end products) will be given thereby, as the activated molecules may regain their normal state by radiation, or on collision with another molecule may liberate the energy as translational energy again. Further, the activated molecule may react with another molecule, and if the reaction is isothermal the new molecules formed may be endowed with sufficient energy to activate by collision. The number of these new molecules will not be included in the Maxwell distributions assumed in the above, and under certain conditions may multiply exponentially until a reaction wave passes through the mixture. [See Abstract 2314 (1923).] J. N. P.

1950. *Eppley Unsaturated Standard Cells at High Temperatures.* **W. C. Vosburgh.** (Optical Soc. America, J. and Rev. Sci. Inst. 12. pp. 393–395, April, 1926.)—Measurements are made with Eppley cells containing amalgams of 13 % and 12·5 % cadmium. At any one temperature the potentials with all cells agreed to within 4×10^{-5} volts. The cells appeared to be as constant at temperatures up to 60° C. as at low temperatures. The composition of the amalgam may vary without affecting the electromotive force provided that it stays within the range for the coexistence at equilibrium of liquid and solid phases. As cells grow older the proportion of cadmium in the amalgam becomes less and the maximum temperature at which they may be used without error becomes lower. J. N. P.

1951. *Individual Ionic Activity and Thermodynamic Computation of Liquid-junction Potentials.* **H. S. Harned.** (J. Phys. Chem. 30. pp. 433–456, April, 1926.)—The continued e.m.f. measurement of cells of the type mentioned [Abstract 1168 (1926)] containing stationary saturated solutions of potassium chloride comprise new data by Swindells. The discussion makes two postulates: that the relative partial free energies of the ions of alkali chlorides in aqueous solutions are additive, and that in KCl solutions E_K equals E_{Cl} for a given ion concentration. It is found that Henderson's equation [Abstracts 1245 (1907) and 1737 (1908)] gives only part of the liquid-junction potential; the missing part involves a knowledge of the individual activity coefficients of all the ions as functions of the transference numbers throughout all the mixtures. The apparent anomaly of the sign of the liquid potential of the junctions $KOH(0 \cdot 1)KCl(m)|KCl(sat.)|KOH(0 \cdot 1)$ is shown to be in accord with the calculations, but the thermodynamic calculation cannot prove or disprove the two postulates mentioned. The conclusions are discussed with respect to Debye and Hückel [Abstract 1267 (1925)]. Both the independent activity theory (change of dielectric constant with electrolytic concentration only in the immediate environment of the ion) and Hückel's theory (uniform dielectric between the ions) are extreme points of view. The true activity values may be between the two; but the dielectric constant is not the only factor to be considered, especially not for complex ions (NO_3, etc.) or unsymmetrical ions (OH). H. B.

1952. *Oxidation Potential of the System Selenium Dioxide-Selenium.* **S. R. Carter, J. A. V. Butler** and **F. James.** (Chem. Soc., J. pp. 930–936, April, 1926.)—The system selenium dioxide-selenium in concentrated hydrochloric acid was investigated, and found to give a reproducible oxidation potential which was measured. The potential was found to be unaffected by light. The influence of concentration of selenium and of selenium dioxide on the potential was determined, and changes of tenfold dilutions resulted in a voltage change of 0·022–0·028 volt. The oxidising action of selenium dioxide is explained by assuming that selenium dioxide dissolves in concentrated acid forming tetravalent ions, which on losing the four charges produce elementary selenium, or that the reduction proceeds *via* the formation of divalent selenium ions, which in turn become reduced to selenium. The existence of divalent selenium compounds is indicated by the solubility of selenium in strong acid solutions containing selenium dioxide. F. J. B.

1953. *The Effect of the Electrode Material on Oxidation Potentials.* **J. A. V. Butler, W. E. Hugh** and **D. H. Hey.** (Faraday Soc., Trans. 22. pp. 24–26, Feb., 1926.)—The condition that the electromotive behaviour of a metal may not affect the oxidation potential is defined by the relation $\pi_1 = \pi_2 + \frac{RT}{nF}\log C$, where π_1 is the oxidation potential of the system, π_2 the normal potential of the metal, and C the concentration of metal ions in the solution. If this condition is not fulfilled initially metal ions must dissolve or deposit until a state of equilibrium is reached. An oxidation potential can only be measured if no appreciable disturbance of the system occurs in this process. With a solution of potassium ferro-ferricyanide in conjunction with a calomel electrode with normal potassium chloride, it is found that electrodes of platinum (platinised and plain), palladium, iridium, osmium, gold, rhodium and ruthenium, a constant potential of 0·1905 ± 0·0001 volt is reached within an hour of making up the cell. Constant potentials are not obtained with electrodes of molybdenum, tungsten, nickel, silver or mercury. With a system containing cuprous-cupric chlorides in aqueous ammonia, which has a lower oxidation potential, the noble metals, silver, nickel and mercury, acquire quickly the same potential, while molybdenum, tungsten, tantalum, arsenic and antimony do not give constant potentials. J. N. P.

1954. *Significance of the Electrode Potential.* **J. Heyrovský.** (Roy. Soc., Proc. 111. pp. 201–202, May 1, 1926.)—The stages of the author's cycle [Abstract 1268 (1923)], denoted by Butler [Abstract 1035 (1924)] as irreversible, are shown to involve the correct free energy terms. Butler's proof that the author's potentials round the cycle are zero is shown to be faulty, owing to his transference of electrons over the metal-solution-vapour interface instead of over the dry metallic surface outside the cell. Avoidance of this wrong step leads to the same relation between the electrode potential and the basic and ionisation constants as was deduced by the author. [See also Abstract 2187 (1924).] T. H. P.

1955. *Decomposition Potential of Fluorine and Potential of Fluorine.* **R. Lorenz.** (Zeits. Elektrochem. 32. pp. 172–173, March, 1926.)—The author criticises the work and conclusions of B. Neumann and H. Richter [Abstract 205 (1926)] and of O. Ruff and W. Busch [Abstract 644 (1926)] from the standpoint of his own numerous experiments on the electrolysis of fused salts. F. J.

1956. *Electrolytic Precipitation of Iron containing Carbon from Complex Compounds with Organic Acids.* **H. Schmidt.** (Zeits. Elektrochem. 32. pp. 33–41, Jan., 1926.)—The precipitation of carbon in the iron obtained by the electrolysis of citrate, tartrate, succinate, oxalate, formate, acetate, and carbonate solutions was found to be similar in all cases, and depended strictly on the kathode potential, and kathode current density on one hand, and on the current yield of iron on the other. This fact is explained by the theory of solution and precipitation, which also leads to the possibility of introducing carbon into an iron kathode in iron-free solutions of the above acids. The carbon is present chiefly in the form that can be evolved as a hydrocarbon gas when the iron is treated with an acid. Measurements of the decomposition potential did not reveal any reduction or the discharge of any unknown ions, such as ionised carbon. Analysis of the kathode liquid remaining after long-continued electrolysis did not show the presence of decomposition products, with the exception of oxalate and formate, which were reduced, and succinate which was reduced to formate. F. J. B.

1957. *The Equivalent Conductivity of Solutions of Sodium Hydroxide and the Mobility of the Hydroxyl Ion.* **H. R. Raikes, A. F. Yorke** and **F. K. Ewart.** (Chem. Soc., J. pp. 630–637, March, 1926.)—The main difficulty which it is found necessary to overcome in determining the conductivity of hydroxides is to eliminate the effect of the carbonate ion arising from reaction with carbon dioxide. Water of a specific conductivity of 0·06–0·07 gemmho. is obtained by the use of a Bourdillon still. Sodium hydroxide solution is prepared by the electrolysis of sodium chloride in a mercury diaphragm cell. Conductivity measurements are made in a cell with platinised electrodes mounted in a thermostat. At concentrations between N/1000 and N/30 the values for the equivalent conductivities are found to be given by the formulæ: At 18° C. $\Lambda_{18^\circ} = 217 - 75{\cdot}7\sqrt{C}$, and at 10° C. $\Lambda_{10^\circ} = 180{\cdot}2 - 44{\cdot}2\sqrt{C}$, C being the concentration of the solution in grm. mols. per litre. The values agree within 0·5 % with those determined by Noyes, but are somewhat higher than Kohlrausch's values. Using Washburn's value for the mobility of the sodium ion, the mobility of the hydroxyl ion is found to be 173·8 and 144·3 at the two temperatures. [See Abstract 1559 (1913).] J. N. P.

1958. *Boron and Boron Suboxide.* **H. H. Kahlenberg.** (Am. Electrochem. Soc., Trans. 47. pp. 23–55; Disc., 55–63, 1925.)—Most of the methods of preparing boron yield impure products. Moissan's method, in which boric anhydride is heated with finely divided magnesium and the mass extracted repeatedly with hot concentrated hydrochloric acid, yields a substance having the composition B_7O, and this gives pure boron when reduced with powdered aluminium in the arc. Pure amorphous boron may be obtained also (1) by passing chlorine over Moissan's product and directing the resulting boron trichloride, together with hydrogen, over an electric arc between copper electrodes, and (2) by electrolysing a fused mixture of potassium carbonate, potassium chloride and boron trioxide, using a copper kathode and a carbon anode. If the potential of the normal calomel electrode is taken as − 0·56 volt, the true single potential of boron is found to be − 0·028 volt when the electrolyte is a potassium borate solution neutral to phenolphthalein and containing 29·2 grammes of boric acid and 3·296 grammes of potassium hydroxide per litre. Boron replaces gold, platinum, palladium, silver, mercury, copper and, very slowly, lead from their solutions, the position of boron in the electro-chemical series being just above lead. From Moissan's product, which consists only partially of elementary boron, it is possible, by removal of the boron, to obtain a new oxide, B_3O. T. H. P.

1959. *Electrolytic Preparation of Potassium Bromate with Carbon Electrodes.* **D. T. Ewing** and **H. W. Schmidt.** (Am. Electrochem. Soc., Trans. 47. pp. 117–121; Disc., 121–122, 1925.)—Carbon electrodes impregnated with paraffin wax are suitable for use in the preparation of potassium bromate by the electrolysis of potassium bromide solutions, and possess advantages over smooth platinum electrodes. The binding power of the wax prevents excessive disintegration of the electrodes. A maximum current efficiency of 82·5 % is obtained with an anode density of 7 amps./dm.^{2}, using 64 amp.-hrs., the temperature of the 35 % potassium bromide solution being 40° C. The addition of a depolariser such as potassium dichromate is essential for high yields. L. M. C.

1960. *"Electrolytes" and "Ionogens."* **W. Blum.** (Am. Electrochem. Soc., Trans. 47. pp. 123–126; Disc., 126–130, 1925.)—The term electrolyte is used in two distinct, and often confusing, senses. Salts such as NaCl, KCl, etc., are electrolytes, and solutions which conduct electricity are also termed electrolytes. The proposition put forward is to confine the use of the term electrolyte to conducting solutions, and to adopt the name "ionogen" previously suggested by A. Smith to mean any salt or chemical compound which can form ions. In the *Discussion*, **L. Kahlenberg** strongly opposed the suggested term, chiefly on the ground that its adoption involved the acceptance of the theory of electrolytic dissociation. F. J. B.

1961. *Effect of Surface on Overvoltage.* **M. Knobel.** (Am. Electrochem. Soc., Trans. 47. pp. 131–136, 1925.)—The effects of surface conditions on overvoltage were investigated by determining the current density overvoltage curves for a smooth and a rough sample of metal. The smooth sample was prepared by cutting from a sheet of the metal, coating it on the back and sides with asphalt, and polishing the face with No. 0000 emery-paper. The rough or "spongy" samples were made by electrodeposition on the smooth surfaces at high current densities. Lead, copper, gold, silver, platinum, cadmium, nickle and palladium were used in both conditions. The results showed that the rougher electrode gave a lower overvoltage than the smooth at the same current density. The reason of the difference is ascribed to the amorphous nature of the spongy metal as compared with the crystalline. The effects of annealing and cold working lead to contradictory results. F. J. B.

1962. *Hydrogen in Zinc Kathodes.* **O. C. Ralston.** (Am. Electrochem. Soc., Trans. 47. pp. 193–198; Disc., 198–199, 1925.)—Zinc deposited on aluminium kathodes from either chloride or sulphate solution develops blisters on the surface after keeping for considerable periods. The phenomena is ascribed to liberation of hydrogen which is originally deposited with the zinc. The probable deleterious effect of such hydrogen liberation on articles which have been zinc-coated is emphasised. L. M. C.

1963. *Transfer Resistance.* **A. L. Ferguson** and **G. van Zyl.** (Am. Electrochem. Soc., Trans. 47. pp. 227–242; Disc., 242–244, 1925.)—The introduction and development of the idea of "transfer resistance" into the literature is critically discussed, and by the use of an apparatus previously described [see Abstract 940 (1925)] it is shown that the differences between the charge and discharge values is not due to a constant resistance. It is further shown that the residual resistance recorded is due to an inherent source of error in the apparatus used for measuring the counter e.m.f. directly and that the charge and discharge values are really the same, there being, therefore, no such thing as "transfer resistance." In the *Discussion,* **W. Blum** refers to the observations of **H. D. Holler,** which, whilst establishing the existence of a resistance at electrodes where a gas is evolved, do not justify the use of the term "transfer resistance." A. B. C. L.

1964. *Fused Electrolytes. A Brief Historical Sketch.* **C. J. Brockman.** (Am. Electrochem. Soc., Trans. 47. pp. 245–248, 1925.)

1965. *Electrodeposition of Metals from Fused Electrolytes.* **A. H. W. Aten, H. J. den Hertog** and **L. Westenberg.** (Am. Electrochem. Soc., Trans. 47. pp. 265–274, 1925.)—The experiments described were mainly on the deposition of silver and copper from their fused halides, but a few qualitative experiments were made with fused manganese, nickel, and iron salts. The kathode consisted usually of the metal to be deposited, but occasionally of platinum, and the anode, which was rotated slowly to keep the temperature uniform, was a wire or rod of the deposited metal or, in the case of manganous chloride, of carbon. With silver kathodes having a crystalline surface, the deposited metal grew as a continuation of the crystals, the new crystals being usually much larger than those from aqueous solutions. Although the grain size of the deposited silver, copper, or nickel varied with the temperature and composition of the bath, the wide differences which exist between the structures of these metals when electrodeposited from aqueous solutions were not observed at the higher temperatures of the fused baths. Polarisation voltage was low in all the electrolytes and decreased as the temperature of the bath rose. T. H. P.

1966. *Anode Effect.* **C. S. Taylor.** (Am. Electrochem. Soc., Trans. 47. pp. 301–311; Disc., 311–316, 1925.)—An analysis is given of the early observations of the anode effect often encountered during the electrolysis of fused salts and of its causes. This effect may result from any combination of conditions which permit local overheating at any point of the surface of the anode. Such overheating establishes a gas film at this point, and by diverting current in this way to other parts of the anode, which are already in a metastable state, overloads them and causes the almost instantaneous spread of the film over the whole surface of the anode. T. H. P.

1967. *Cerium-free Misch Metal.* **A. P. Thompson** and **H. C. Kremers.** (Am. Electrochem. Soc., Trans. 47. pp. 345–350; Disc., 351–352, 1925.)—Misch metal is produced from the cerium group of rare earths left after extracting the thorium and didymium from the monazite sands in the gas-mantle industry. The misch metals are used as reducing agents and also as scavengers of cast iron, but the presence of cerium was considered objectionable because such alloys catch fire in the ladle. The authors find, however, that their two misch metals, free of cerium, were more pyrophoric, possibly because they are harder than cerium, having kindling temperatures of 195° and 280° C. The cerium is precipitated as CeO_2 by adding permanganate to the solution of the rare earth salts in nitric acid while continuously neutralising with calcium carbonate. The other metals are then precipitated as oxalates, which are ignited, and the oxides are dissolved in hydrochloric acid for electrolysis in iron cells. During the *Discussion* by **M. A. Hunter** and **L. Kahlenberg** it was stated that the pyrophoric character may be due to the presence of hydrogen in the metals. H. B.

1968. *Metallic Electrolytic Cerium.* **H. C. Kremers** and **H. Beuker.** (Am. Electrochem. Soc., Trans. 47. pp. 353–360; Disc., 360–364, 1925.)—Cerium was prepared by the method of Muthmann [Abstract 1079 (1904)] as applied by Hirsch [Abstract 223 (1912)], but the iron crucible was replaced by a cell turned out of solid graphite. The $CeCl_3$ is mixed with 90 % of NaCl; some carbide is always formed, even below 800° C.; the presence of some basic salt in the chloride increased the fluidity of the melt and was not injurious. The decomposition required 4 volts; the anodic density should be low for all the rare earth metals. The metal resembles cobalt and steel, tarnishes rapidly to steel-blue in air, even when lacquered, turns yellow, is slowly attacked by cold water and rapidly by acids; it is rather soft, and very ductile and malleable. Like most metals of the rare earths, it can hardly be fused in an ordinary vacuum; the melting-point (Hirsch 635° C.) was not determined. The density is 6·77, the Brinell hardness (500 kg. load) 21, and the kindling temperature (the temperature of the furnace at which the metal filings will glow when sprinkled or brought into the muffle) 165°. The metal is less pyrophoric than its harder alloys and is good for cleaning vacuum tubes of oxygen and probably nitrogen. H. B.

1969. *Metallic Neodymium.* **H. C. Kremers.** (Am. Electrochem. Soc., Trans. 47. pp. 365–371; Disc., 371, 1925.)—The reduction of anhydrous $NdCl_3$ only gave impure powders. Electrolysis of Nd_2O_3 fused in a cryolite bath yielded alloys rich in aluminium; electrolysis of an oxide solution in fused NdF_3 and KF was quite unsatisfactory. Electrolysis of the fused chloride with some NaCl at 6 volts and moderate anode density gave in the first instance probably a sub-chloride which was further reduced to neodymium. The metal is silvery-white, turns yellowish in air in a few hours and then blue-grey, is not ductile and is attacked by hot water and acids. The density is 7·05 at 15°. The kindling temperature is 270° C.; the metal is not pyrophoric, but the alloys with iron, aluminium, etc., are very slightly. The metal used contained 3 % of iron. H. B.